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ANDALEX RESOURCES, INC.  
CENTENNIAL PROJECT  
007/019

AMENDMENT TO  
THE MINING AND RECLAMATION PLAN  
(APPENDIX X)

***TO ADD FIFTEEN ADDITIONAL  
GOB GAS VENT HOLES***

***CONSISTING OF:***

***PRIMARY HOLES: #10, #11, #12, #13, #14, #15, #16, & #17***  
***and***  
***ALTERNATE HOLES: #10A, #11A, #12A, #13A, #14A, #15A,***  
***& #16A***

NOTE: ALL CHANGES TO THE PREVIOUSLY APPROVED  
APPENDIX X ARE INCLUDED IN THIS WORK VOLUME  
AND ARE SHOWN IN RED

File in:

☐ Confidential

☒ Expandable

Refer to Record No 0014 Date 3/16/05

In C/ 007/19, 2007, Incoming

For additional information

ANDALEX RESOURCES, INC.

**APPENDIX X**

**CENTENNIAL PROJECT  
GOB GAS VENT HOLES**

C/007/019

(Revised)  
**FEBRUARY 2007**



(Revised)  
FEBRUARY 2007

**CHAPTER 1**  
**LEGAL, FINANCIAL, COMPLIANCE AND**  
**RELATED INFORMATION**

## TABLE OF CONTENTS (Continued)

### LIST OF TABLES

<b>Table 1-1</b>	<b>Well Site Locations</b> .....	<b>1-2</b>
	.....	<b>1-2a</b>
<b>Table 1-2</b>	<b>Disturbed Acres by Well Site</b> .....	<b>1-6</b>

### LIST OF FIGURES

<b>Figure 1-1</b>	<b>Gob Gas Vent Hole Locations</b>
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## 110 MINIMUM REQUIREMENTS FOR LEGAL, FINANCIAL, COMPLIANCE AND RELATED INFORMATION

### 111 Introduction

This project is a "Ventilation Assistance Program", wherein hazardous "gob gas" from the longwall will be partially vented to the surface. The quantity and quality of the vented gas will be the same as that presently being discharged at the mine fan. The discharged "gob gas" will be of no commercial value.

Five holes have been approved and drilled in 2005. These are holes GVH#1, GVH#3, GVH#4, GVH#5 and GVH#6. Four additional holes were completed in early 2006 - GVH#5A, GVH #7, GVH #8 and GVH #9. Three additional holes were approved in late 2006 - GVH #5B, GVH #7A and GVH #8A. Of these, only 2 holes were drilled - GVH#7A and GVH#8. Due to required changes in the mining plan, hole GVH#5B will not be drilled and has been shown as eliminated, although the site has been approved and included in the bonding. GVH #7A was drilled on the existing disturbed pad area of GVH #7.

This proposal is for an additional 8 primary holes - GVH#10, GVH#11, GVH#12, GVH#13, GVH#14, GVH#15, GVH#16, and GVH#17 and 7 alternate holes - GVH#10A, GVH#11A, GVH#12A, GVH#13A, GVH#14A, GVH#15A, GVH#16A. The alternate holes would be located midway between the primary holes.

It is possible not all of the holes will be needed; however, all are proposed to be permitted in case they are needed.

The holes will be located on surface property owned by Dave R. and Mildred Cave, et al., and Mathis Land, Inc. The mineral rights are owned by Mathis Land, Inc. and the United States Government (B.L.M.) And are under lease by Andalex Resources, Inc.

The existing and proposed hole locations are described in Table 1-1 and are shown on Figure 1-1.

**TABLE 1-1**  
**Gob Gas Well Locations (see Figure 1-1)**  
**Deadman Canyon, Utah Quadrangle, Salt Lake Meridian**

Hole Number	Status	Section	Township and Range
GVH-1	Hole Completed	31	T.12S., R.11E.
GVH-3	Hole Completed	31	T.12S., R.11E.
GVH-4	Hole Completed	1	T.13S., R.10E.
GVH-5	Hole Completed	31	T.12S., R.11E.
GVH-6	Hole Completed	31	T.12S., R.11E.
GVH-5A	Hole Completed	31	T.12S., R.11E.
GVH-7, 7A*	Hole Completed	31	T.12S., R.11E.
GVH-8	Hole Completed	36	T.12S., R.10E.
GVH-9	Hole Completed	36	T.12S., R.10E.
GVH-5B	Eliminated	31	T.12S., R.11E.
GVH-8A	Hole Completed	36	T.12S., R.10E.
GVH-10	Proposed	31	T.12S., R.11E.
GVH-10A	Proposed	31	T.12S., R.11E.
GVH-11	Proposed	31	T.12S., R.11E.
GVH-11A	Proposed	31	T.12S., R.11E.
GVH-12	Proposed	31	T.12S., R.11E.
GVH-12A	Proposed	31	T.12S., R.11E.
GVH-13	Proposed	31	T.12S., R.11E.
GVH-13A	Proposed	31	T.12S., R.11E.
GVH-14	Proposed	31	T.12S., R.11E.
GVH-14A	Proposed	36	T.12S., R.10E.
GVH-15	Proposed	36	T.12S., R.10E.
GVH-15A	Proposed	36	T.12S., R.10E.
GVH-16	Proposed	36	T.12S., R.10E.
GVH-16A	Proposed	36	T.12S., R.10E.
GVH-17	Proposed	36	T.12S., R.10E.

\* Redrilled on existing pad GVH#7.

STATION	MINE COORDINATE SYSTEM (SURVEY FEET)				UTM NAD 27 (SURVEY FEET)		WGS 1984	
	NORTHING	EASTING	ELEVATION		NORTHING	EASTING	LATITUDE	LONGITUDE
GVH 1	510178.9	2218871.9	8527.4		14428218	1717912	39°43'51.5"N	110°43'30.4"W
GVH 3	510246.2	2214978.2	8510.1		14428308	1714021	39°43'52.5"N	110°44'20.2"W
GVH 4	510196.9	2212651.7	8589.2		14428273	1711697	39°43'52.2"N	110°44'50.0"W
GVH 5	511682.1	2218840.4	8463.1		14429720	1717889	39°44'06.3"N	110°43'30.6"W
GVH 5A	511717.6	2218039.0	8476.1		14429760	1717089	39°44'06.8"N	110°43'40.9"W
GVH 6	511735.7	2216541.0	8477.8		14429787	1715592	39°44'07.1"N	110°44'00.1"W
GVH 7	511708.0	2214865.8	8385.9		14429770	1713918	39°44'07.0"N	110°44'21.5"W
GVH 7A	511708.0	2214865.8	8385.9		14429770	1713918	39°44'07.0"N	110°44'21.5"W
GVH 8	511695.0	2213369.8	8453.1		14429766	1712423	39°44'07.0"N	110°44'40.6"W
GVH 8A	511680.0	2212688.7	8400.0		14429755	1711742	39°44'06.9"N	110°44'49.4"W
GVH 9	511665.0	2212007.5	8511.0		14429744	1711062	39°44'06.8"N	110°44'58.1"W
GVH 10	513232.5	2218979.4	8282.0		14431268	1718037	39°44'21.6"N	110°43'28.7"W
GVH 10A	513227.1	2218446.1			14431266	1717504		
GVH 11	513221.6	2217912.8	8358.1		14431264	1716971	39°44'21.6"N	110°43'42.3"W
GVH 11A	513213.5	2217382.1			14431259	1716441		
GVH 12	513205.3	2216851.3	8339.7		14431254	1715911	39°44'21.6"N	110°43'55.9"W
GVH 12A	513197.5	2216317.0			14431249	1715377		
GVH 13	513189.8	2215782.6	8182.6		14431245	1714843	39°44'21.5"N	110°44'09.6"W
GVH 13A	513187.5	2215252.1			14431245	1714313		
GVH 14	513185.1	2214721.5	8293.7		14431246	1713783	39°44'21.6"N	110°44'23.2"W
GVH 14A	513180.3	2214189.2			14431245	1713251		
GVH 15	513175.5	2213657.0	8337.7		14431243	1712719	39°44'21.6"N	110°44'36.8"W
GVH 15A	513171.1	2213124.4			14431242	1712187		
GVH 16	513166.7	2212591.9	8429.4		14431241	1711655	39°44'21.6"N	110°44'50.4"W
GVH 16A	513161.9	2212059.4			14431239	1711123		
GVH 17	513157.2	2211527.0	8426.7		14431238	1710591	39°44'21.6"N	110°45'04.1"W

## **112 Identification of Interests**

Refer to the same section of the approved M&RP.

### **112.100 Business Entity**

Refer to the same section of the approved M&RP.

### **112.200 Applicant and Operator**

Applicant and Operator: Andalex Resources, Inc  
Tower Division  
P.O. Box 902  
Price, Utah 84501  
Telephone: (435) 637-5385

Contact Person and  
Resident Agent: **Dave Shaver**  
Andalex Resources, Inc  
Tower Division  
P.O. Box 902  
Price, Utah 84501  
Telephone: (435) 637-5385

**Responsibility:** Andalex Resources, Inc. is responsible for submission of information and will pay abandoned mine reclamation fees.

### **112.300 Officers of the Applicant**

Refer to the same section of the approved M&RP.

### **112.400 Coal Mining and Reclamation Operation Owned or Controlled**

Refer to the same section of the approved M&RP.

### **112.500 Legal or Equitable Owner of the Surface and Mineral Properties**

The legal and equitable owner of the surface and mineral properties to be affected by this operation during the duration of the permit period are listed below:

**TABLE 1-2  
Disturbed Acres by Well Site**

Well Site	Status	Disturbed Acres	
		Original	Existing
GVH-1	Hole Completed	1.15	0.52
GVH-3	Hole Completed	1.11	0.55
GVH-4	Hole Completed	0.95	0.45
GVH-5	Hole Completed	0.97	0.51
GVH-6	Hole Completed	1.49	0.46
GVH-5A	Hole Completed	0.76	0.59
GVH-7, 7A	Hole Completed	0.50	0.33
GVH-8	Hole Completed	0.65	0.65
GVH-9	Hole Completed	0.81	0.81
GVH-5B	Eliminated	-	-
GVH-8A	Hole Completed	1.25	0.49
GVH-10	Proposed	-	-
GVH-10A	Proposed	-	-
GVH-11	Proposed	-	-
GVH-11A	Proposed	-	-
GVH-12	Proposed	-	-
GVH-12A	Proposed	-	-
GVH-13	Proposed	-	-
GVH-13A	Proposed	-	-
GVH-14	Proposed	-	-
GVH-14A	Proposed	-	-
GVH-15	Proposed	-	-
GVH-15A	Proposed	-	-
GVH-16	Proposed	-	-
GVH-16A	Proposed	-	-
GVH-17	Proposed	-	-

\* Redrilled on existing pad GVH#7.



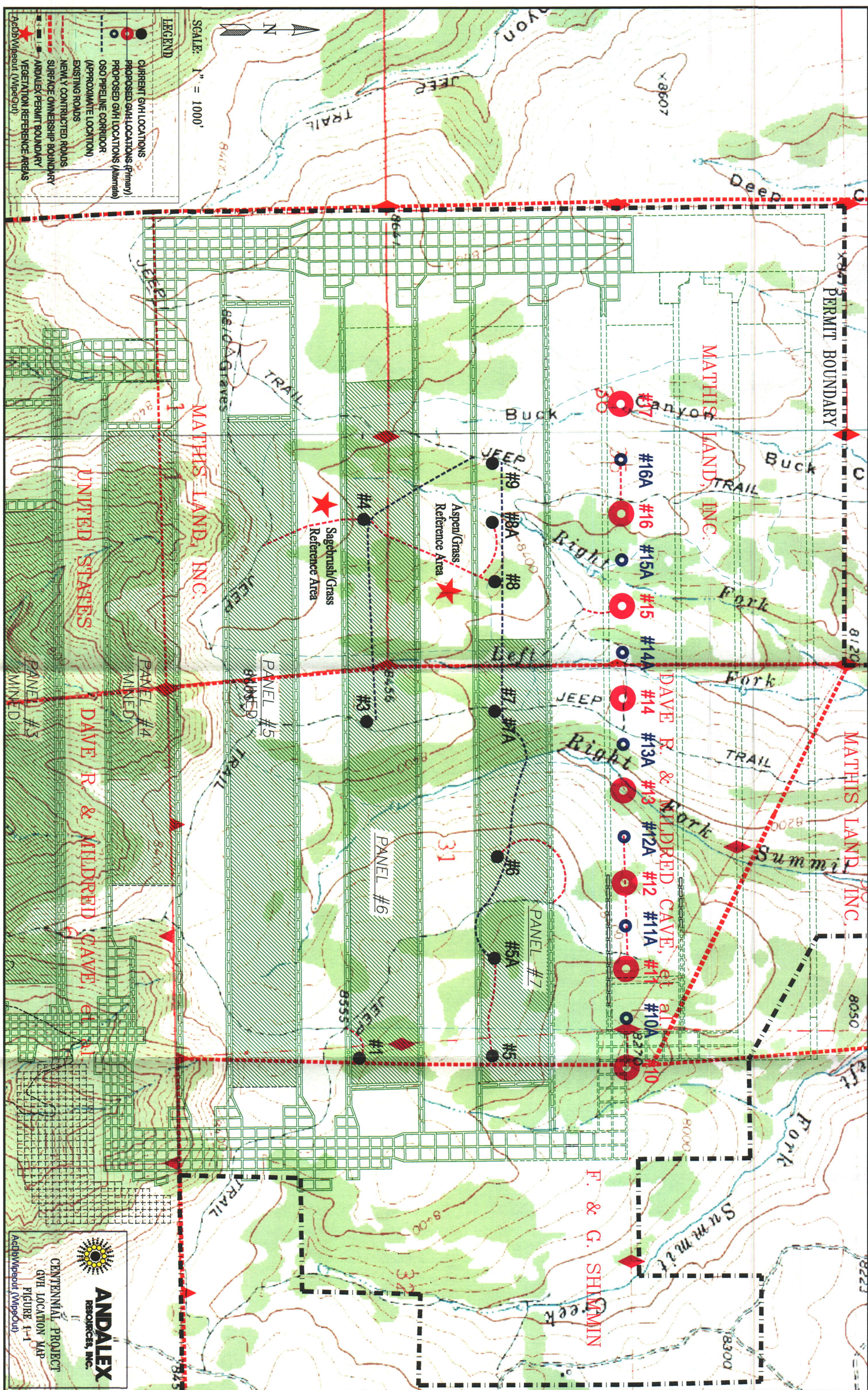




FIGURE 1-1

GVH LOCATION MAP

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**CHAPTER 2**  
**SOILS**

**TABLE OF CONTENTS (Continued)**

**LIST OF TABLES**

**Table 2-1** Topsoil Volumes ..... 2-3  
**Table 2-2** Topsoil Stockpile Dimensions ..... 2-6  
**Table 2-3** Topsoil Distribution Thickness ..... 2-11

**LIST OF ATTACHMENTS**

**Attachment 2-1**      Soil Inventory and Assessment - **Approved Holes GVH-1 through GVH-9**  
  
**Attachment 2-2**      Soil Inventory and Assessment - **Proposed Holes GVH-10 through GVH-17**

## 210 INTRODUCTION

This chapter and associated attachments address the pertinent data required for the 11 existing degassification well sites for the Centennial Project (GVH#1, GVH#2, GVH#4, GVH#5, GVH#5A, GVH#6, GVH#7, GVH#8, GVH#9, GVH#7A, GVH#8A) as well as the 15 proposed additional well sites (GVH#10, GVH#10A, GVH#11, GVH#11A, GVH#12, GVH#12A, GVH#13, GVH#13A, GVH#14, GVH#14A, GVH#15, GVH#15A, GVH#16, GVH#16A, GVH#17). Only those sections of the Division regulations that apply to the well sites have been addressed. The remainder of the regulations have already been addressed in the existing M&RP. The M&RP and this document contain pertinent information relating to the identification, management, and reclamation activities associated with the soil resources.

Due to required changes in the mining plan, hole GVH#5B will not be drilled and has been shown as eliminated, although the site has been approved and included in the bonding.

## 220 ENVIRONMENTAL DESCRIPTION

The well sites range in elevation from approximately 8400 to 8600 feet. The well sites are located in the Summit Creek/Emma Park area of the Book Cliffs. General vegetation includes sagebrush-grass, aspen and oak brush communities.

### 221 Prime Farmland Investigation

Due to limiting terrain, lack of water for irrigation and no evidence of past cultivation of the sites, it is concluded that no prime farmland exists within the area of the well site disturbance.

### 222 Soil Survey

#### 221.100 Soils Map

An order 1 soil survey has been conducted of the area to help define the previous conditions at well sites 1, 3, 4, 5 and 6. This information will be used for final reclamation for these sites. An order 1 Soil Survey was also conducted for completed sites GVH#5A, GVH#7, GVH#8 and GVH#9. Results of the order 1 surveys are provided in Attachment 2-1 "Soil Inventory and Assessment" - Approved Holes GVH#1 through GVH#9. Due to the amount of soil data gathered during the order 1 surveys done for the existing nine nearby sites and the consistent nature of the soil characteristics in the area, assumptions were made about the nature of the soils at sites GVH#7A and GVH#8A. These assumptions included depth of available topsoil and quality of material.

An order 1 soil survey has also been completed for proposed primary holes GVH#10 through GVH#17. Results of this survey are included in Attachment 2-1 "Soil Inventory and Assessment - Proposed Holes GVH#10 through GVH#17". It should be noted that the soils survey was conducted on the primary holes numbers only (i.e. GVH#10, GVH#11, etc.). Each of the primary holes has an alternate or additional location proposed (i.e. GVH#10A, GVH#11A, etc.). Based on the amount of soil data gathered for the previously approved holes, as well as that for the proposed holes, and the consistent nature of the soil characteristics in the area, assumptions have been made about the nature of the soils at the alternate proposed sites. These assumptions include depth of available topsoil and quality of material. Topsoil at these alternate sites will be sampled and analyzed at the time of salvage. Results of these analyses will then be added to Attachment 2-2.

#### **222.200 Soil Identification**

See Attachment 2-1, and 2-2.

#### **222.300 Soil Description**

See Attachment 2-1, and 2-2.

#### **222.400 Soil Productivity**

See Attachment 2-1, and 2-2.

**TABLE 2-1**  
**Topsoil Volumes**

Well No.	Status	Cubic Yards of Material	
		Original	Remaining*
GVH-1	Hole Completed	2778	1250
GVH-3	Hole Completed	2689	1333
GVH-4	Hole Completed	2300	1083
GVH-5	Hole Completed	2347	1228
GVH-6	Hole Completed	3611	1111
GVH-5A	Hole Completed	1839	1389
GVH-7, 7A	Hole Completed	1210	926
GVH-8	Hole Completed	1573	1573
GVH-9	Hole Completed	1960	1960
GVH-5B	Eliminated	-	-
GVH-8A	Hole Completed	3025	1186
GVH-10	Proposed	2480	-
GVH-10A	Proposed	2400	-
GVH-11	Proposed	2480	-
GVH-11A	Proposed	2400	-
GVH-12	Proposed	807	-
GVH-12A	Proposed	2400	-
GVH-13	Proposed	2044	-
GVH-13A	Proposed	2400	-
GVH-14	Proposed	2823	-
GVH-14A	Proposed	2400	-
GVH-15	Proposed	1775	-
GVH-15A	Proposed	2400	-
GVH-16	Proposed	2346	-
GVH-16A	Proposed	2400	-
GVH-17	Proposed	2420	-

\* Remaining soil is after original pad reduction and contemporaneous reclamation.

Note: 2400 CY per Well is assumed until final surveys are done. Actual size of the pads could be less than 1 acre, in which case the volume stored will be reduced accordingly.

## **223 Soil Characterization**

See attachment 2-1, and 2-2.

## **224 Substitute Topsoil**

Andalex Resources, Inc. does not plan to use substitute topsoil as growth media unless described in Section 222.400.

## **230 OPERATION PLAN**

### **231 General Requirements**

#### **231.100 Removing and Storing Topsoil Methods**

The topsoil will be removed (and replaced) to a depth of 18 inches where the thickness exists, stockpiled and protected with a berm and/or silt fence. A qualified person will be on site during soil salvage to monitor and supervise the operation for the purpose of maximizing salvage volumes. Prior to topsoil salvage shrubs/vegetation will be removed and placed/wind rowed along the inside perimeter of the disturbed area. Stockpiled topsoil will not be allowed to remain at the angle of repose (1h:1v) for a period of longer than two weeks. During contemporaneous reclamation, or after two weeks, the stockpiled topsoil slopes will be reduced to less than 2h:1v. The topsoil will then be immediately seeded after the proper angle is achieved. Reseeding will use the approved seed mixture found in ARI's Mining and Reclamation Plan (page 3-21), or a mix recommended by the Division, and will be hand broadcast, raked in slightly and mulched with straw or alfalfa hay. Hand broadcasting requires twice the seed rate per acre as drilling.

After the topsoil is removed, the mud pit will be excavated and the soils from the mud pit excavation will be stored immediately adjacent to the mud pit. Mud pit excavation of subsoil will be approximately 110 CY at each well site. Generally, it is expected that mud pits will be excavated in an area roughly 200 square feet by 15 feet deep. A larger area is possible, should the depth not be achievable, or multiple pits may be employed. However a mud pit volume of roughly 3000 cubic feet per drill site is needed. A portable container for drilling fluids will be used if necessary, should there not be sufficient subsoil depth to excavate a mud pit (where bed rock is encountered).

**TABLE 2-2**  
**Topsoil Stockpile Dimensions**

Well No.	Status	Length (ft)	Width (ft)	Height (ft)
GVH-1	Existing	75	40	11
GVH-3	Existing	100	40	9
GVH-4	Existing	95	35	9
GVH-5	Existing	100	35	9.5
GVH-6	Existing	105	35	8.5
GVH-5A	Existing	100	25	15
GVH-7, 7A	Existing	100	25	10
GVH-8	Existing	140	25	12
GVH-9	Existing	100	25	17.5
GVH-5B	Eliminated	-	-	-
GVH-8A	Existing	100	40	16
GVH-10	*Proposed	100	40	16
GVH-10A	*Proposed	100	40	16
GVH-11	*Proposed	100	40	16
GVH-11A	*Proposed	100	40	16
GVH-12	*Proposed	100	40	16
GVH-12A	*Proposed	100	40	16
GVH-13	*Proposed	100	40	16
GVH-13A	*Proposed	100	40	16
GVH-14	*Proposed	100	40	16
GVH-14A	*Proposed	100	40	16
GVH-15	*Proposed	100	40	16
GVH-15A	*Proposed	100	40	16
GVH-16	*Proposed	100	40	16
GVH-16A	*Proposed	100	40	16
GVH-17	*Proposed	100	40	16

\* These are approximate dimensions of the topsoil stockpile for the proposed well sites, based on the estimated CY from Table 2-1. Actual construction dimensions may vary.

See section 234.200 for detailed information on the topsoil stockpile(s).



**TABLE 2-3**  
**Approximate Topsoil Distribution Thickness**

Well Site No.	Status	Topsoil Thickness (inches)
GVH-1	Actual	18
GVH-2	Actual	18
GVH-3	Actual	18
GVH-5	Actual	18
GVH-5A	Actual	18
GVH-6	Actual	18
GVH-7, 7A	Actual	18
GVH-8	Actual	18
GVH-9	Actual	18
GVH-5B	Eliminated	-
GVH-8A	Actual	18
GVH-10	Proposed	18
GVH-10A	Proposed	18
GVH-11	Proposed	18
GVH-11A	Proposed	18
GVH-12	Proposed	6
GVH-12A	Proposed	18
GVH-13	Proposed	22
GVH-13A	Proposed	18
GVH-14	Proposed	21
GVH-14A	Proposed	18
GVH-15	Proposed	12
GVH-15A	Proposed	18
GVH-16	Proposed	18
GVH-16A	Proposed	18
GVH-17	Proposed	18

**ATTACHMENT 2-2**  
**SOIL INVENTORY AND ASSESSMENT**

**PROPOSED HOLES GVH-10 through GVH-17**

FOR:

SOILS REPORT, GVH 10

BRUCE CHESSLER

JULY 12, 2006

SEE ATTACHMENT 2-2  
IN THE "CLEAN COPY"

FOR:

SOILS REPORT, GVH 11-17

BRUCE CHESSLER

DECEMBER 5, 2006

SEE ATTACHMENT 2-2  
IN THE "CLEAN COPY"

(Revised)  
FEBRUARY 2007

**CHAPTER 3**  
**BIOLOGY**



## TABLE OF CONTENTS (Continued)

<u>Section</u>	<u>Page</u>
<b>357 Revegetation: Extended Responsibility Period . . . . .</b>	<b>3-15</b>
357.100 Extended Period Begins . . . . .	3-15
357.200 Vegetation Parameters . . . . .	3-15
357.300 Husbandry Practices . . . . .	3-16
<b>358 Protection of Fish, Wildlife, and Related Environmental Values .</b>	<b>3-16</b>
358.100 Existence of Endangered or Threatened Species . . . . .	3-16
358.200 Bald and Golden Eagles . . . . .	3-16
358.300 Taking of Endangered or Threatened Species . . . . .	3-16
358.400 Replacement of Wetland or Riparian Vegetation . . . . .	3-16
358.500 Manmade Wildlife Protection Measures . . . . .	3-16

### LIST OF TABLES

<b>Table 3-1</b>	Federal and State Listed T&E Species - Carbon County . . . . .	3-6
<b>Table 3-2</b>	Potential Water Depletion to Colorado River Drainage . . . . .	3-7
<b>Table 3-3</b>	Reclamation Seed Mix . . . . .	3-13

### LIST OF ATTACHMENTS

<b>Attachment 3-1</b>	Vegetation Inventory - <b>Approved Holes GVH-1 through GVH-9</b>
<b>Attachment 3-2</b>	Threatened, Endangered, and Sensitive Species Information
<b>Attachment 3-3</b>	2005 Raptor Survey (Relocated to Confidential Binder)
<b>Attachment 3-4</b>	Photos of GVH Sites
<b>Attachment 3-5</b>	<b>Vegetation Inventory - Proposed Holes GVH-10 through GVH-17</b>

## **310 INTRODUCTION**

This chapter presents a description of the biological resources found on the completed Centennial Project gob gas vent hole sites GVH#1, GVH#3, GVH#4, GVH#5, GVH#6, GVH#5A, GVH#7, GVH#7A, GVH#8, GVH#8A and GVH #9, as well as the proposed sites GVH#10, GVH#10A, GVH#11, GVH#11A, GVH#12, GVH#12A, GVH#13, GVH#13A, GVH#14, GVH#14A, GVH#15, GVH#15A, GVH#16, GVH#16A, GVH#17. Details for each of the sites are provided in this Appendix.

Due to required changes in the mining plan, hole GVH#5B will not be drilled and has been shown as eliminated, although the site has been approved and included in the bonding.

### **311 Vegetation, Fish and Wildlife Resources**

Vegetative, fish, and wildlife resource conditions in and adjacent to the proposed degassification wells are discussed in Section 320 of this submittal and the approved M&RP.

### **312 Potential Impacts to Vegetative, Fish, and Wildlife Resources**

Potential impacts to vegetative, fish, and wildlife resources and the associated mitigation plan is presented in Section 330 and 340 of this chapter.

### **313 Description of Reclamation Plan**

The reclamation plan used to restore the vegetative, fish, and wildlife resources to a condition suitable for the post mining land use is presented in Section 340.

## **320 ENVIRONMENTAL DESCRIPTION**

### **321 Vegetation Information**

This section and the approved M&RP contain the environmental descriptions of the vegetation for the permit and adjacent areas.

Andalex Resources has been drilling "gob" gas vent holes as a safety requirement necessary to conduct their coal mining operations within the plateaus of the Book Cliffs mountain range. Because of the extreme urgency of the situation in early 2005, permitting of some emergency gas holes began in January 2005, with drilling proceeding soon afterwards. Initially, drill holes numbered GVH-01, GVH-02, GVH-03 were proposed for drilling (GVH-02 was later dropped from the plan). Following these drilling activities, additional drilling was necessary in the late-winter/early spring months the same year (sites: GVH-05 and GVH-06). Because it was necessary for the drilling to proceed during in the winter and spring months, or when quantitative assessment of the impacted plant communities was not possible, Andalex employed "Range Site" methods in the permitting process to drive the revegetation plan and provide final revegetation standards of success. More gas holes were necessary for venting requirements in the spring of 2005 beginning with GVH-04. Prior to disturbance by the drill rig, the plant communities to be impacted by

the drilling operations were quantitatively sampled including the proposed access road and drill pad. Additionally, a "Reference Area" with the same plant community was sampled. The Reference Area was used for comparisons of the proposed disturbed site at that time and will also be used at the time of final reclamation for standards of final revegetation success.

The next completed gob gas holes were numbered GVH-05A, GVH-07, GVH-08, and GVH-09. The plant communities that would be impacted by these drilling operations were quantitatively sampled in the growing season of 2005. Reference Areas were also chosen and sampled for these communities during the same time period. The following document was submitted to Andalex to report the results of the 2005 vegetation sampling period; and is included in Attachment 3-1 of this Appendix:

VEGETATION OF THE GAS VENT HOLES:  
GVH-04, GVH-05A, GVH-07, GVH-08,  
GVH-09 & REFERENCE AREAS  
2005

for the  
CENTENNIAL MINE

by  
MT. NEBO SCIENTIFIC, INC.

January 2006

Because the aforementioned emergency drill sites GVH-01, GVH-03, GVH-05 and GVH-06 were constructed in the winter and early spring months, or before vegetation sampling could be conducted, Reference Areas for them were chosen later in the growing season of 2005 when a better assessment of them could be made. These Reference Areas will be used later as standards for final revegetation success at these sites instead of using the Range Site method mentioned above. Based on a qualitative assessment of these sites, the **Sagebrush/Grass Reference Area** as reported in the above document will be used for the emergency, or first drill sites.

Three additional gob gas holes were approved in 2006 - GVH #5B, GVH #7A and GVH #8A. Required vegetation information for each of these sites is included in a report generated by Mt. Nebo Scientific which has been included in Attachment 3-1 - **Vegetation Inventory - Approved Holes GVH-1 through GVH-9**.

Note: GVH#5B will not be drilled and has been eliminated.



Fifteen additional gob gas holes are being proposed with this submittal - GVH#10, GVH#10A, GVH#11, GVH#11A, GVH#12, GVH#12A, GVH#13, GVH#13A, GVH#14, GVH#14A, GVH#15, GVH#15A, GVH#16, GVH#16A, and GVH#17.

Required vegetation information for the proposed sites is included in a new report generated by Mt. Nebo Scientific which is included as Attachment 3-5 - Vegetation Inventory - Proposed Holes GVH-10 through GVH-17. It should be noted that quantitative data were sampled and recorded for each of the proposed primary site locations GVH-10 through GVH-17, in the growing season of 2006. Appropriate reference areas were also chosen and sampled at that time. As with the soils, it was determined with the Division, that because of the vast amount of data and the consistency of the proposed site vegetation, additional sampling would not be required for each of the proposed alternate holes GVH-10A through GVH-16A. Instead, each of these holes will be evaluated separately based on available data for similar or adjacent sites.

The vegetation reports for Attachment 3-5 will consist of 2 separate reports. The main report will address all sampling and data collection for the primary proposed sites, GVH-10 through GVH-17. The second report will address the proposed alternate sites GVH-10A through GVH-16A, along with extrapolated data and conclusions for each of these sites.

The reports are entitled as follows:

VEGETATION OF THE GAS VENT HOLES:  
GVH-10, GVH-11, GVH-12, GVH-13, GVH-14, GVH-15, GVH-16, GVH-17, &  
REFERENCE AREAS  
2006  
FOR THE  
CENTENNIAL MINE

VEGETATION DESCRIPTIONS OF THE INTERMEDIATE GAS VENT HOLES:  
GVH-10 through GVH-17  
2006  
FOR THE  
CENTENNIAL MINE

### **321.100 Plant Communities Within the Proposed Permit Area**

Plate 19A of the M&RP shows the sites to be generally in the sagebrush-grass, aspen and oak brush communities. Vegetation specific to each of the sites is provided in this Appendix. A qualitative vegetative inventory (analysis) was completed during the summers of 2005 and 2006. (See Attachment 3-1 and 3-5)

Also, ARI has taken photographs of the proposed sites prior to disturbance. These photo locations are identifiable and repeatable. Although the photo locations were not staked, landmarks in the photos provide for identification as well as direction and location. The photos are included in Attachment 3-4.

### **321.200 Land Productivity Prior to Mining**

Land productivity prior to drilling has been estimated at approximately 1800 pounds per acre, based on range sites of High Mountain Loam. This productivity is assumed for all completed holes GVH-1 through GVH-9, as well as for all proposed holes GVH-10 through GVH-17.

### **322 Fish and Wildlife Information**

Fish and wildlife information associated with the degas wells is provided in this chapter. A summary of the fish and wildlife resource information for the permit and adjacent areas is contained in Section 322.100 through 322.200 of the approved M&RP.

#### **322.100 Level of Detail**

The scope and level of detail within the "Gob Gas Vent Holes" amendment are sufficient to design the protection and enhancement plan for wildlife and fish associated with the degas wells. Additional information pertaining to fish and wildlife in the permit area is located in the M&RP.

#### **322.200 Site-Specific Resource Information**

**Raptors** - An aerial raptor nest survey was done of the area by the Utah Division of Wildlife Resource personnel in 2004. The results of the survey are provided in Appendix D of the M&RP. Additional surveys have been done in 2005 and 2006, and are included with this submittal in the Confidential Binder for the Centennial Project.

A raptor survey will be conducted of the well site areas, each year that the wells are in operation.

**Bats** - No known open mine shafts, caves, adits or other man made structures that might provide habitats for bats are known to exist in the degas project area. The sites are open and the lack of a food source would force the bats to seek habitat and nourishment elsewhere.

**Threatened and Endangered Plant and Wildlife Species** - There are no known federally or state listed threatened and endangered plant and wildlife species within the sites planned for degassification wells. This is based on research and analysis by Mt. Nebo Scientific of Springville, Utah and EIS of Helper Utah as well as on-site evaluation by UDOGM specialists. The Bureau of Land Management has also reviewed the access and drill sites and has stated that although this area represents important habitat for both Mule deer and Elk, it is not characterized as crucial or critical.

### **322.300 Fish and Wildlife Service Review**

If requested, Andalex Resources, Inc. authorizes the release of information pertaining to Section 322 and 333 to the U.S. Fish And Wildlife Service Regional and Field Office for their review.

### **323 Maps and Aerial Photographs**

Location of the well sites can be seen in Figure 1-1 of this submittal.

### **323.100 Location and Boundary of Proposed Reference Area**

Reference areas for all well sites have been established as described in Section 321. Subsequent holes will also use standard reference areas including baseline data.

### **323.200 Elevation and Locations of Monitoring Stations**

N/A

### **323.300 Facilities for Protection and Enhancement**

Section 333.300 and 358.500 of the approved M&RP contain additional discussion pertaining to protective measures to be taken by Andalex Resources, Inc.

### **323.400 Vegetation Type and Plant Communities**

Vegetative types and plant communities are outlined in the vegetative reports in Attachments 3-1 and 3-5.

## **330 OPERATION PLAN**

### **331 Measures Taken to Disturb the Smallest Possible Area**

The well sites will be sized to disturb the smallest acreage possible and still meet the requirements for the drilling equipment. The drainage control required will be built to satisfy the environmental requirements. Please refer to the typical proposed site plans for the gob gas wells which show estimated dimensions, location and type of sediment control, location of topsoil storage as well as approximate size and set-up of equipment.

### **332 Description of Anticipated Impacts of Subsidence**

Refer to Section 525.

**ATTACHMENT 3-1**  
**VEGETATION INVENTORY**  
**APPROVED HOLES GVH-1 through GVH-9**

**ATTACHMENT 3-5  
VEGETATION INVENTORY  
PROPOSED HOLES GVH-11 through GVH-17**



FOR:

**VEGETATION REPORT, GVH 10-17**  
**MT NEBO SCIENTIFIC**  
**FEBRUARY, 2007**

SEE ATTACHMENT 3-5  
IN THE "CLEAN COPY"



FOR:

**VEGETATION REPORT, GVH 10A-16A**  
**MT NEBO SCIENTIFIC**  
**FEBRUARY, 2007**

SEE ATTACHMENT 3-5  
IN THE "CLEAN COPY"

(Revised)  
FEBRUARY 2007

**CHAPTER 4**  
**LAND USE AND AIR QUALITY**



## LIST OF ATTACHMENTS

- Attachment 4-1** Cultural Resource Survey and Inventory - Approved holes GVH-1 through GVH-9.
- Attachment 4-2** Surface Land Owner Notification (Moved to Confidential Binder)
- Attachment 4-3** Cultural Resource Survey and Inventory - Proposed Holes GVH-10 through GVH-17

## **410 LAND USE**

### **411 Environmental Description**

A statement of the conditions and capabilities of the land to be affected by mining and reclamation operations follows in this section.

#### **411.100 Premining Land Use**

The area is utilized for the landowners private use, including hunting and as open range for livestock and wildlife.

#### **411.110 Land Use Map and Narrative**

Refer to the same section of the approved M&RP.

#### **411.120 Land Capability**

The major plant communities at the well sites are identified in Section 321. No cultivated lands lie within the well boundaries, due to the limiting terrain and lack of water for irrigation. Refer to Section 321.200, of this submittal for forage production per acre for each well site.

#### **411.130 Land Use Description**

The wells are located on land administered by Dave R. & Mildred Cave, et al., and Mathis Land, Inc. and zoned by Carbon County for mining and grazing (MG-1).

No industrial or municipal facilities are located on or immediately adjacent to the well sites.

#### **411.140 Cultural and Historic Resources Information**

For Gob Gas Holes 1, 3, 4, 5 and 6, preliminary research and file search has been conducted by Senco-Phenix of Price, Utah and the research indicates that there is a very low probability of the occurrence of cultural resources at the proposed drill sites. Senco-Phenix has also completed a Cultural Resource Survey of the approved sites GVH#5A, GVH#7, GVH#8 and GVH#9, as well as approved sites GVH#5B and GVH #8A. (GVH #7A was a re-drill on the existing disturbed pad of GVH #7, which as been previously surveyed for archeological resources.) Due to required changes in the mining plan, hole GVH#5B will not be drilled and has been shown as eliminated, although the site has been approved and included in the bonding. Results of these surveys are included in Attachment 4-1 "Cultural Resources Survey and Inventory - Approved Holes GVH-1 through GVH-9".

A total of 15 additional well sites are proposed with this submittal - GVH#10, GVH#10A, GVH#11, GVH#11A, GVH#12, GVH#12A, GVH#13, GVH#13A, GVH#14, GVH#14A,

GVH#15, GVH#15A, GVH#16, GVH#16A, GVH#17. Each of the proposed hole locations (GVH#10 through GVH#17) along with access corridors, has had an intensive cultural resource survey and inventory completed on them. The results of these surveys are included in Attachment 4-3 - "Cultural Resource Survey and Inventory - Proposed Holes GVH-10 through GVH-17".

It should be noted that all sites had findings of "No Effect" and all were recommended for Archaeological Clearance.

Andalex Resources, Inc. agrees to notify the Division and State Historical Preservation Office (SHPO) of previously unidentified cultural resources discovered in the course of operations. Andalex also agrees to have any such cultural resources evaluated in terms of NRHP eligibility criteria. Protection of eligible cultural resources will be in accordance with Division and SHPO requirements. Andalex will also instruct its employees that it is a violation of federal and state law to collect individual artifacts or to otherwise disturb cultural resources.

#### **411.200 Previous Mining Activity**

Andalex Resource, Inc. has no knowledge of the removal of coal or other minerals in the well site areas.

### **412 Reclamation Plan**

#### **412.100 Postmining Land-Use Plan**

All uses of the land prior to the wells construction/operation and the capacity of the land to support prior alternate uses will remain available throughout the life of the sites.

Andalex Resource, Inc. intends the postmining land use to be livestock and wildlife grazing and other uses as indicated by the land owner (hunting, etc.). Final reclamation activities will be completed in a manner to provide the lands to parallel the premining land use.

#### **412.200 Land Owner or Surface Manager Comments**

Surface lands are owned by Dave R. & Mildred Cave, et al., and Mathis Land, Inc. Appropriate landowner approvals have been obtained for the proposed wells. Required notification of drilling will be sent to the landowners prior to start. Copies of the notification letters have been included in Attachment 4-2.

**ATTACHMENT 4-3**  
**CULTURAL RESOURCE SURVEY AND INVENTORY**  
**PROPOSED HOLES GVH-10 through GVH-17**  
**(Relocated to Confidential Binder)**

**ATTACHMENT 4-1**  
**CULTURAL RESOURCE SURVEY AND INVENTORY**  
**APPROVED HOLES GVH-1 through GVH-9.**  
**(Relocated to Confidential Binder)**



FOR:

CULTURAL RESOURCES SURVEY, GVH 10

MICHAEL POLK

MAY 31, 2006

SEE ATTACHMENT 4-3  
IN THE "CLEAN COPY"



FOR:

CULTURAL RESOURCES SURVEY, GVH 11-17

SENCO-PHENIX

SEPTEMBER 29, 2006

SEE ATTACHMENT 4-3  
IN THE "CLEAN COPY"



FOR:

**CULTURAL RESOURCES SURVEY, GVH 10A-16A**  
**SENCO-PHENIX**  
**DECEMBER 6, 2006**

SEE ATTACHMENT 4-3  
IN THE "CLEAN COPY"

(Revised)  
FEBRUARY 2007

**CHAPTER 5**  
**ENGINEERING**

## TABLE OF CONTENTS (Continued)

<u>Section</u>	<u>Page</u>
553.500 Highwall From Previously Mined Areas . . . . .	5-14
553.600 Previously Mined Areas . . . . .	5-14
553.700 Backfilling and Grading - Thin Overburden . . . . .	5-14
553.800 Backfilling and Grading - Thick Overburden . . . . .	5-14
553.900 Regrading of Settled and Revegetated Fills . . . . .	5-14
<b>560 PERFORMANCE STANDARDS . . . . .</b>	<b>5-15</b>

## LIST OF FIGURES

<b>Figure 5-1</b>	Typical Gob Gas Vent Hole Drilling Plan
<b>Figure 5-2</b>	Typical Gob Gas Vent Hole Operation Plan
<b>Figure 5-3</b>	Typical Gob Gas Vent Hole Pad Cross Section
<b>Figure 5-4</b>	Typical Gob Gas Vent Hole
<b>Figure 5-5</b>	Typical Road Cross Sections
<b>Figure 5-6</b>	Projected Gob Gas Vent Hole Reclamation Schedule
<b>Figure 5-7</b>	GVH #1 - As-Constructed
<b>Figure 5-8</b>	GVH #3 - As-Constructed
<b>Figure 5-9</b>	GVH #4 - As-Constructed
<b>Figure 5-10</b>	GVH #5 - As-Constructed
<b>Figure 5-11</b>	GVH #6 - As-Constructed
<b>Figure 5-12</b>	GVH #5A - As-Constructed
<b>Figure 5-13</b>	GVH #7/#7A - As-Constructed
<b>Figure 5-14</b>	GVH #8 - As-Constructed
<b>Figure 5-15</b>	GVH #9 - As-Constructed
<b>Figure 5-16</b>	GVH #8A - As-Constructed

## **510 INTRODUCTION**

This chapter provides a discussion of general engineering aspects, an operation plan, a reclamation plan, design criteria, and performance standards related to the degassification well sites. The activities associated with the construction and reclamation of the well sites have been or will be designed, located, constructed, maintained, and reclaimed in accordance with the operation and reclamation plans.

Designs and other information herein presented may be of a general nature or in the form of typical for proposed sites not yet accessible for detailed surveying or studies. Site specific information will be provided in this chapter as it becomes available.

### **511 General Requirements**

The permit application includes descriptions of construction, maintenance, and reclamation operations of the **completed and** proposed well sites with maps and plans. Potential environmental impact as well as methods and calculations utilized to achieve compliance with the design criteria are also presented.

Completed holes are GVH#1, GVH#3, GVH#4, GVH#5, GVH#5A, GVH#6, GVH#7, GVH#7A, GVH#8, GVH#8A, and GVH#9. The following is a list of holes proposed for approval - GVH#10, GVH#10A, GVH#11, GVH#11A, GVH#12, GVH#12A, GVH#13, GVH#13A, GVH#14, GVH#14A, GVH#15, GVH#15A, GVH#16, GVH#16A and GVH#17. All holes are shown on Figure 1-1.

Due to required changes in the mining plan, hole GVH#5B will not be drilled and has been shown as eliminated, although the site has been approved and included in the bonding.

### **512 Certification**

Where required by the regulations, cross sections and maps in this permit application have been prepared by or under the direction of, and certified by, qualified registered professional engineers or land surveyors. As appropriate, these persons were assisted by experts in the fields of hydrology, geology, biology, etc.

#### **512.100 Cross Sections and Maps**

Cross sections for the degassification well pads are provided upon completion of surveys. Typical road cross sections are shown on Figure 5-5.



## **512.200 Plans and Engineering Designs**

**Excess Spoil** - No excess spoil will be generated from the well sites.

**Durable Rock Fills** - No durable rock fills will exist at the well sites.

**Coal Mine Waste** - No coal mine waste will exist at the well sites.

**Impoundments** - Refer to Section 733.200 of this submittal.

**Ancillary Roads** - Short sections of road may be required to access certain well sites. Topsoil will be stripped from the road alignment and stored with the topsoil stripped from the pad area prior to grading the new access road. When possible, well sites will be placed on existing roads.

Existing and proposed access routes to all well sites are shown on Figure 1-1 of this Appendix.

**Variance from Approximate Original Contour** - No variance from approximate original contour is required for the well sites.

## **513 Compliance with MSHA Regulations and MSHA Approval**

### **513.100 Coal Processing Waste Dams and Embankments**

No coal processing waste dams and embankments will exist at the well sites.

### **513.200 Impoundments and Sedimentation Ponds**

Refer to Section 733.200 of this submittal.

### **513.300 Underground Development Waste, Coal Processing Waste, and Excess Spoil**

No underground waste, coal processing waste, and excess spoil will exist at the well sites.

### **513.400 Refuse Piles**

No refuse piles will exist at the well sites.

### **513.500 Underground Openings to the Surface**

The well will be equipped with a valve that will be closed and locked when not in use. A typical well head is shown in Figure 5-4.

## **520 OPERATION PLAN**

### **521 General**

Detailed maps are provided of each of the well sites when conditions allow access.

#### **521.100 Cross Sections and Maps**

**Existing Surface and Subsurface Facilities Features** - No buildings are located on or within 1,000 feet of any of the well sites.

**Landowner, Right-of-Entry, and Public Interest** - The land which the wells will be drilled on is owned by Dave R. & Mildred Cave, et al., and Mathis Land, Inc. Andalex Resources, Inc. **has completed** landowner agreements to allow access for the construction and drilling of the wells (see Attachment 4-2).

**Mining Sequence and Planned Subsidence** - Refer to Section 525.

**Land Surface Configuration** - Surface contours of undisturbed well sites will be included when completed.

**Surface Facilities** - No permanent surface facilities will exist at the well sites.

#### **521.200 Signs and Markers**

**Mine and Permit Identification Signs** - A mine and permit identification sign will be displayed at each well site. This sign will be a design that can be easily seen and read, will be made of durable material, will conform to local regulation, and will be maintained until after the release of all bonds for the well site areas. The sign will contain the following information:

- Mine name,
- Company name,
- Company address and telephone number,
- MSHA identification number, and
- Permanent program permit identification number

**Perimeter Markers** - The perimeter of all areas affected will be clearly marked before beginning drilling activities. The markers will be a design that can be easily seen and read, will be made of durable material, will conform to local regulations, and will be maintained until after the release of all bonds for the permit area.

**Buffer Zone Markers** - Stream buffer zone markers will not be required at any of the well sites.



GVH-6 - This is a constructed access road running from Road GVH-5 to the GVH-6 Site. The road is approximately 16' wide, 4300' long and has an average slope of 2.67%. It is constructed on native material, with gravel used as needed on soft areas. Drainage is controlled by a combination of ditches and berms. This road will be removed and reclaimed unless otherwise directed by the landowner.

Ridge Road - This is an existing road along the ridge above the Right and Left Forks of Deadman Canyon. The road is approximately 16' wide, 7100' long and has an average grade of 3.10%. It runs westward from the top of the Right Fork of Deadman Canyon to the turnoff to the road to GVH-9. The road is constructed on native material and being on the ridgeline, has need for only minimal drainage control in the form of ditches where needed. This road will remain in place after the project is completed.

GVH-3 - This is an existing road from the Ridge Road to the GVH-3 Site. The road is approximately 16' wide, 1200' long and has an average grade of 4.17%. The road is constructed on native material and hydrologic controls consist of berms and ditches. This road is not scheduled for removal after the project is completed.

GVH-7 - This section of road is from GVH-3 to GVH-7 and is a continuation of the existing road to GVH-3. This section is approximately 16' wide, 1600' long and at an average grade of 8.13%. The road is constructed on native material and hydrologic controls are primarily from ditches. This road is also scheduled to remain after the project.

GVH-7A - This site will be a re-drill of existing site GVH-7, and will use the existing access road to GVH-7.

GVH-8 - This road is from GVH-4 to GVH-8. The road is approximately 16' wide, 1700' long and at an average grade of 8.0%. The road is on native material and hydrologic controls are primarily from ditches.

GVH-8A - This site is accessed by a short spur road to be constructed from the road which presently provides access to GVH-8. The spur road is approximately 650' long, 16' wide with an average grade of approximately 7.5%. The road is constructed on native material with runoff control primarily by berms. The spur road will be removed and reclaimed unless otherwise directed by the landowner.

GVH-4 - This road runs from the Ridge Road to the GVH-4 Site. This road was constructed by ARI, and is approximately 16' wide, 1100' long at an average grade of approximately 3.64%. The road was constructed on native material, and runoff is controlled by ditches and berms with containment on the pad. This road will be removed and reclaimed unless otherwise requested by the landowner.

GVH-9 - This is an existing road from the Ridge Road to the GVH-9 Site. The road is approximately 16' wide, 3500' long and has an average grade of approximately 8.14%. The road is constructed on native material and runoff is controlled by ditches and berms. Since this is also an existing road, it will not be removed unless requested by the landowner.

GVH-10 - This is an existing road from the GVH-5 site to the GVH-10 site. The road parallels the fence line and is approximately 16' wide, 1700' long and has an average grade of approximately 12.5%. The road is constructed on native material, and hydrologic controls are primarily from ditches and berms. The road is not scheduled for removal after the project is completed.

GVH-10A - This site will be on a constructed road from GVH-10 to the GVH-10A site. The road will be approximately 800' in length, 16' wide and at an average grade of -3.75%. The road will be constructed on native material with hydrologic controls primarily by ditches and berms. This road is not scheduled to be removed.

GVH-11 - This site will be on the existing road below GVH-6. The road is approximately 16' wide at an average grade of -5.00%. The existing road is on native material with drainage controls primarily by ditches or berms. This road is not scheduled to be removed.

GVH-11A - This road will be constructed from the existing road at site GVH#11. The constructed road will be approximately 450' in length, 16' wide and at an average grade of -8.88%. The road will be built on native material with runoff control by ditches or berms. This road is scheduled to be removed and reclaimed.

GVH-12 - This road will also be constructed from the above referenced road to GVH#11A. It will be approximately 600' in length, 16' wide and at an average grade of -10.00%. It will be built on native material and runoff control will be primarily from ditches or berms. This road will be removed and reclaimed.

GVH-12A - This road will be constructed from the above referenced road to GVH#12. The new road will be approximately 600' long, 16' wide at an average grade of -7.5%. It will be built on native material with runoff control by ditches or berms. This road is also planned to be removed and reclaimed.

GVH-13 - This site is on an existing road on the east side of the Right Fork of Summit Creek, as shown on Figure 1-1. The road is approximately 16' wide and at an average grade of -6.67%. It is built on native material with runoff control by ditches. This road is not scheduled to be removed and reclaimed at the completion of operations.

GVH-13A - This site is on an existing road below GVH-7. The existing road is approximately 16' wide and at an average grade of -8.13%. The road is constructed on native material with hydrologic controls primarily from ditches. This road is scheduled to remain.

GVH-14 - This site is also located on the existing road below GVH-7 as referenced above. It is also approximately 16' wide, on native material with runoff control by ditches. This road will also remain after the project.

GVH-14A - This site is also on the above referenced existing road for GVH-13A and GVH-14. The road is approximately 16' wide and constructed on native material. Runoff control is primarily by ditches. This road will also remain after the project.

GVH-15 - This will be a newly constructed road from the existing road below GVH-8. The new road will be approximately 600' long, 16' wide and have an average grade of -10.83%. It will be constructed on native material with runoff control by ditches and/or berms. This road will be removed and reclaimed.

GVH-15A - This road will be constructed from the existing road below GVH-9. It will be approximately 900' long, 16' wide and have an average grade of -13.33%. It will be constructed on native materials with runoff control by ditches, water bars and/or berms. It is scheduled to be removed and reclaimed.

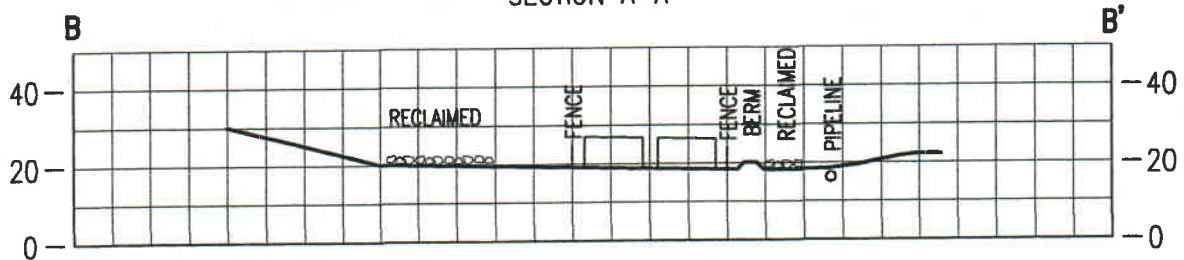
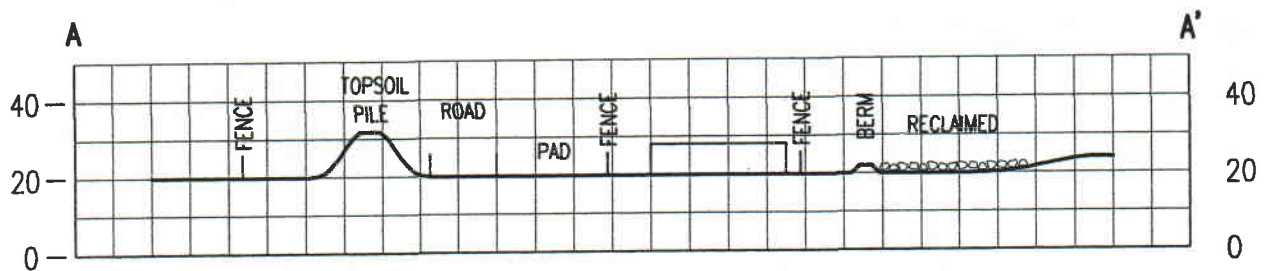
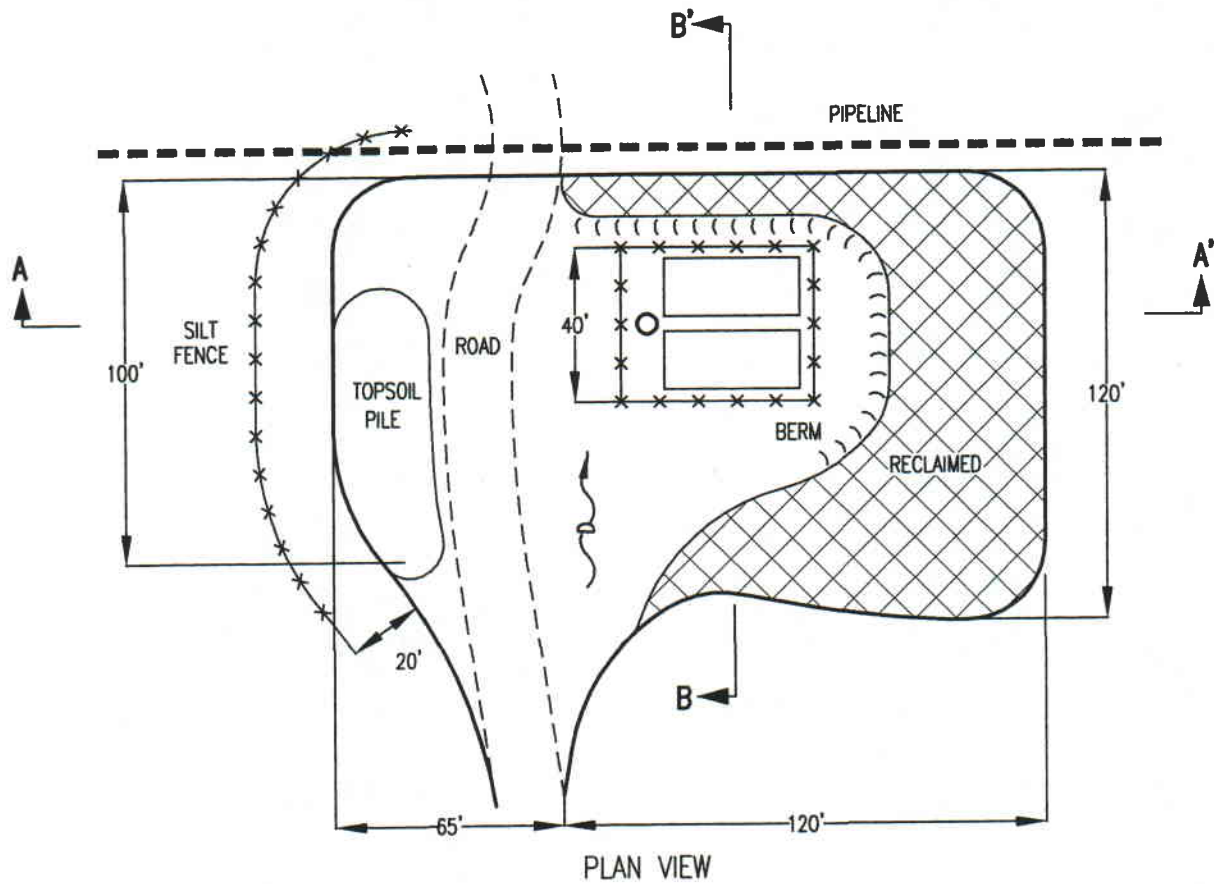
GVH-16 - This site is on the existing road below GVH-9. The existing road is approximately 16' wide with an average grade of - 8.14%. The road is on native material with ditches and berms for runoff control. This road is scheduled to remain.

GVH-16A - This site will be accessed by a new road constructed from the above referenced road below GVH-9. The new road will be approximately 500' long, 16' wide with an average grade of +8.00%. It will be on native material with runoff control by ditches an/or berms. The new portion of road is scheduled to be removed and reclaimed.

GVH-17 - This site will be accessed from the existing OSO pipeline corridor. The GVH-17 road will be approximately 400' long, 16' wide and have an average grade of -8.00%. It will be on native material with runoff control by ditches and/or berms. This road will be removed and reclaimed when the project is completed.

**All roads described above are shown on Figure 1-1 of this Appendix.**

FIGURE 5-13



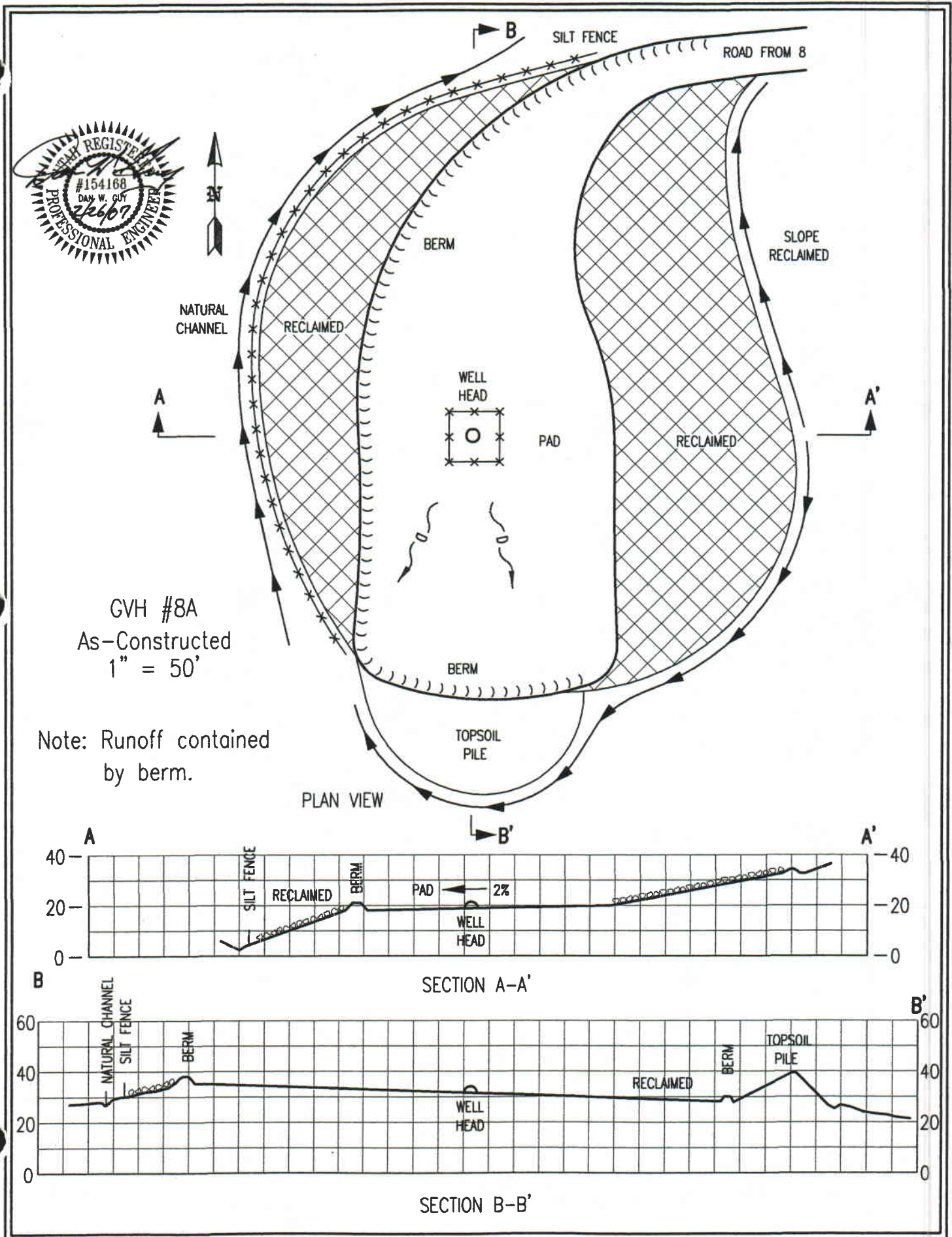
Note: Runoff from pad treated by silt fence.

GVH #7/7A  
As-Constructed  
1" = 50'





FIGURE 5-16



(Revised)  
FEBRUARY 2007

**CHAPTER 6**  
**GEOLOGY**



(Revised)  
FEBRUARY 2007

**CHAPTER 7**  
**HYDROLOGY**

## **710 INTRODUCTION**

### **711 General Requirements**

This chapter presents a description of the following:

- Proposed operations and the potential impacts to the hydrologic balance;
- Methods of compliance with design criteria and the calculations utilized to show compliance; and
- Applicable hydrologic performance standards.

As-constructed drawings are provided for completed sites in Figures 5-7 through 5-15. Hydrology calculations are provided in Attachment 7-1.

### **712 Certification**

All required maps, plans, and cross sections presented in this chapter have been or will be certified by a qualified, registered professional engineer.

### **713 Inspection**

Inspections are not required since no permanent impoundments will exist at the well sites.

## **720 ENVIRONMENTAL DESCRIPTION**

### **721 General Requirements**

This section presents a description of the pre-mining hydrologic resources within the well pad and their adjacent areas that may be affected or impacted by the proposed coal mining and reclamation operations.

Completed holes are GVH#1, GVH#3, GVH#4, GVH#5, GVH#5A, GVH#6, GVH#7, GVH#7A, GVH#8, GVH#8A, and GVH#9. The following is a list of holes proposed for approval - GVH#10, GVH#10A, GVH#11, GVH#11A, GVH#12, GVH#12A, GVH#13, GVH#13A, GVH#14, GVH#14A, GVH#15, GVH#15A, GVH#16, GVH#16A and GVH#17. All holes are shown on Figure 1-1.

Due to required changes in the mining plan, hole GVH#5B will not be drilled and has been shown as eliminated, although the site has been approved and included in the bonding.

The following is a summary of runoff calculations for the existing as well as the proposed gob gas vent holes, along with controls and treatment of runoff.

GVH Runoff Summary					
Hole	Status	Disturbed Area (ac.)	Peak Flow (cfs)	Runoff Volume (ac. ft.)	Control/Treatment
GVH#1	Hole Completed	0.52	0.44	0.04	Berm/Containment
GVH#3	Hole Completed	0.55	0.47	0.04	Berm/Containment
GVH#4	Hole Completed	0.45	0.38	0.04	Berm/Containment/Silt Fence
GVH#5	Hole Completed	0.51	0.44	0.04	Berm/Containment
GVH#6	Hole Completed	0.46	0.39	0.04	Berm/Containment
GVH#5A	Hole Completed	0.59	0.50	0.05	Berm/Silt Fence
GVH#7, 7A*	Hole Completed	0.33	0.28	0.03	Berm/Silt Fence
GVH#8	Hole Completed	0.65	0.55	0.05	Silt Fence
GVH#9	Hole Completed	0.81	0.68	0.06	Berm/Containment
GVH#5B	Eliminated	-	-	-	-
GVH#8A	Hole Completed	0.49	0.42	0.04	-
GVH#10	Proposed	1.0	0.86	0.08	Berm/Containment
GVH#10A	Proposed	1.0	0.86	0.08	Berm/Containment
GVH#11	Proposed	1.0	0.86	0.08	Berm/Containment
GVH#11A	Proposed	1.0	0.86	0.08	Berm/Containment
GVH#12	Proposed	1.0	0.86	0.08	Berm/Containment
GVH#12A	Proposed	1.0	0.86	0.08	Berm/Containment
GVH#13	Proposed	1.0	0.86	0.08	Berm/Containment
GVH#13A	Proposed	1.0	0.86	0.08	Berm/Containment
GVH#14	Proposed	1.0	0.86	0.08	Berm/Containment
GVH#14A	Proposed	1.0	0.86	0.08	Berm/Containment
GVH#15	Proposed	1.0	0.86	0.08	Berm/Containment
GVH#15A	Proposed	1.0	0.86	0.08	Berm/Containment
GVH#16	Proposed	1.0	0.86	0.08	Berm/Containment
GVH#16A	Proposed	1.0	0.86	0.08	Berm/Containment
GVH#17	Proposed	1.0	0.86	0.08	Berm/Containment

\* GVH #7A (re-drill) on existing pad area GVH #7.

(Revised)  
FEBRUARY 2007

**CHAPTER 8**  
**BONDING AND INSURANCE**



## **810 BONDING DEFINITIONS AND DIVERSION RESPONSIBILITIES**

This chapter provides information regarding the bonding for reclamation of the completed and proposed gob gas vent hole sites at the Centennial Project. Andalex, Resources, Inc. has on file with the Division a bond payable to the Division for performance of all requirements of the State Program.

Completed holes are GVH#1, GVH#3, GVH#4, GVH#5, GVH#5A, GVH#6, GVH#7, GVH#7A, GVH#8, GVH#8A, and GVH#9. The following is a list of holes proposed for approval - GVH#10, GVH#10A, GVH#11, GVH#11A, GVH#12, GVH#12A, GVH#13, GVH#13A, GVH#14, GVH#14A, GVH#15, GVH#15A, GVH#16, GVH#16A and GVH#17. All holes are shown on Figure 1-1.

Due to required changes in the mining plan, hole GVH#5B will not be drilled and has been shown as eliminated, although the site has been approved and included in the existing bonding.

## **820 REQUIREMENTS TO FILE A BOND**

A description of the disturbed area location for each well site is found in Chapter 1, Table 1-1. Reclamation of the disturbed areas are discussed in Section 340 of this submittal. The performance bond period is for the duration of coal mining and reclamation operations including the extended period designated by the Division. The bond is in the form of a surety bond and is described in Section 860 of the M&RP.

## **830 DETERMINATION OF BOND AMOUNT**

The existing reclamation bond is posted in the amount of \$1,211,839.00. It has been determined that the total bonding amount for each additional GVH will be \$28,000 per hole. Additional bonding of \$224,000 is presently being secured for the 8 primary sites (GVH#10, GVH#11, GVH#12, GVH#13, GVH#14, GVH#15, GVH#16, and GVH#17). Bonding will be in place for each site prior to any surface disturbing activities.

## **840 GENERAL TERMS AND CONDITIONS OF THE BOND**

Refer to Chapter 8 and Appendix B of the approved M&RP.

BONDING CALCULATIONS FOR:

**8 EA. GOB GAS VENT HOLES**

**#10, #11, #12, #13, #14, #15, #16, #17**

Bonding Calculations  
Centennial Mine C/007/019

Bond Summary

Direct Costs

Subtotal Demolition and Removal	\$371,538.00
Subtotal Backfilling and Grading	\$426,800.00
Subtotal Revegetation	\$210,074.00
Direct Costs	\$1,008,412.00

Indirect Costs

Mob/Demob	\$100,841.00	10.0%
Contingency	\$50,421.00	5.0%
Engineering Redesign	\$25,210.00	2.5%
Main Office Expense	\$68,572.00	6.8%
Project Mainagement Fee	\$25,210.00	2.5%
Subtotal Indirect Costs	\$270,254.00	26.8%

Total Cost \$1,278,666.00

Escalation factor 0.012  
Number of years 4  
Escalation \$62,490.00

Reclamation Cost \$1,341,156.00

Bond Amount (rounded to nearest \$1,000)  
2009 Dollars \$1,341,000.00

Bond Posted \$1,211,839.00

Difference Between Cost Estimate and Bond \$129,161.00  
Percent Difference -9.63%



Task ID	Ref.	Description	Materials	Means Reference Number	Unit Cost	Unit	Length	Width	Height	Diameter	Area	Volume	Weight	Density	Time	Number	Unit	Swell Factor	Quantity	Unit	Cost
		Aberdeen Mine																			
		Loadout Bin No 01																			1800
		Concrete No 02																			325
		Reclaim No 03																			2880
		Conveyor No 04																			800
		Hopper No 05																			1200
		Conveyor No 06																			1300
		Tunnel No 07																			1728
		Fan No 08																			640
		Substation No 09																			1914
		Water Tank No 10																			188
		Portals No 11																			2560
		Subtotal																			15135
		Main Office																			
		Main Office No 12																			10889
		Subtotal																			10889
		Bath House																			
		Bath House No 13																			5150
		Subtotal																			5150
		Upper Pinnacle																			
		Substation No 14																			3373
		Loadout Bin No 15																			2245
		Conveyor No 16																			640
		Reclaim No 17																			461
		Hopper No 18																			1152
		Conveyor No 19																			740
		Tunnel No 20																			1728
		Water Tank No 21																			282
		Rock Dust Tank No 22																			314
		Trailers No 23																			3038
		Portals No 24																			14560
		Subtotal																			28531
		Lower Pinnacle																			
		Office No 25																			1999
		Portals No 26																			7680
		Subtotal																			9679
		Shop/Warehouse																			
		Shop/Warehouse No 27																			39105
		Subtotal																			39105
		Apex																			
		Loadout No 28																			1857
		Conveyor No 29																			1120
		Reclaim No 30																			3284
		Hopper No 31																			1843
		Conveyor No 32																			1000
		Tunnel No 33																			2400
		Portals No 34																			13920
		Water Tank No 35																			188
		Shed No 36																			800
		Magazines No 37																			38
		Substation No 38																			1917
		Office No 39																			1755
		Subtotal																			29602
		Culverts																			
		Culverts No 41																			18100
		Subtotal																			18100
		Gob Vent Well																			
		Gob Vent Well 1, 3, 4, 5, 6, 7, 8, 9																			73980
		Gob Vent Well 2679																			24660
		Gob Vent Well 10 thru 17																			65760
		Subtotal																			164400
		Vent Shaft Blowing Fan																			
		2679																			48537
		Aberdeen Substation																			2110
		Subtotal																			50647
		Total																			371538



Task ID	Ref.	Description	Materials	Means Reference Number	Unit Cost	Unit	Length	Width	Height	Diameter	Area	Volume	Weight	Density	Time	Number	Unit	Swell Factor	Quantity	Unit	Cost
2359		GoB Vent Well 10 thru 17																			
		7A is a redrill																			
		Structure's Demolition Cost	Mechanical equipment heavy	15045 300 3600	805 /ton																
		Plug Well	Plug Well	AML3	5000 EA																
		Rubble's Weight (exclude steel)																			
		Truck's Capacity																			
		Haulage																			
		Transportation Cost Non Steel Truck																			
		Transportation Cost Non Steel Drive																			
		Disposal Cost Non Steel																			
		Steel's Weight																			
		Truck's Capacity																			
		Haulage																			
		Transportation Cost Steel Truck																			
		Transportation Cost Steel Truck Drive																			
		Disposal Cost Steel																			
		Subtotal																			65760
		Equipment's Disposal Cost																			
		Dismanitling Cost																			
		Equipment's Vol. Demolished																			
		Loading Costs																			
		Transport Costs																			
		Disposal Costs																			
		Subtotal																			
		Concrete Demolition																			
		Demolition Cost																			
		Concrete's Vol. Demolished																			
		Loading Cost																			
		Transportation Cost																			
		Disposal Costs																			
		Subtotal																			
		Concrete Demolition																			
		Demolition Cost																			
		Concrete's Vol. Demolished																			
		Loading Cost																			
		Transportation Cost																			
		Disposal Costs																			
		Subtotal																			
		Concrete Demolition																			
		Demolition Cost																			
		Concrete's Vol. Demolished																			
		Loading Cost																			
		Transportation Cost																			
		Disposal Costs																			
		Subtotal																			
		Total																			65760

Task ID	Task Description	Equipment Cost	Hourly Operating Costs	Equipment Overhead	Operator's Hourly Wage Rate	Hourly Cost	Number of Men or Eq.	Total Eq. & Lab. Costs	Units	Quantity	Units	Production Rate	Units	Equip. + Labor Time/Dls.	Units	Cost
	Gob Hole 10 thru 17															
	Grading 5,000 CY per hole															
	Backfill and rough grade pond, canyon and bench areas															
	D7R Series II (8-55) (2nd2004)	10565	41.1	0.1	52	183.24	1	183.24 \$/HR		40000 CY		250 CY/HR		160 HR		26116
	Subtotal															26116
	Topsail 1,600 CY per hole															
	Heal and spread topsail															
	D7R Series II (8-55) (2nd2004)	13720	53.4	0.1	52	196.49	1	196.49 \$/HR		12600 CY		250 CY/HR		51.2 HR		10060
	Subtotal															10060
	Support Personnel															
	4,000 gal H2O truck Diesel (20-16) (2N04)	3350	19.85	0.1	42	84.77	1	84.77 \$/HR						32 HR		2713
	Subtotal															2713
	Total															38891

Task ID		Equipment Cost	Hourly Operating Costs	Equipment Overhead	Operator's Hourly Wage Rate	Hourly Cost	Number of Men or Eq.	Total Eq. & Lab. Costs	Units	Quantity	Units	Production Rate	Units	Equip. + Labor Time/Dis.	Units	Cost
	Centennial Mine															
	Mine Site															332737
	Gob Hole															49414
2359	Gob Hole 5A, 8A, 7A															11758
	Gob Hole 10 thru 17															38691
	Total															426600

Task ID	Equipment Cost	Hourly Operating Costs	Equipment Overhead	Operator's Hourly Wage Rate	Hourly Cost	Number of Men or Eq.	Total Eq. & Lab. Costs	Units	Quantity	Units	Production Rate	Units	Equip. + Labor Time/Ds.	Units	Cost
Gob Hole 10 thru 17															
Grading															
Backfill and rough grade pond, canyon and bench areas															
D7R Series II (9-55) (2nd2004)	10565	41.1	0.1	52	163.24	1	163.24 \$/HR		40000 CY		250 CY/HR		180 HR		28118
Subtotal															28118
Topsell 1 600 CY per hole															
Head and spread topsell															
D7R Series II (9-55) (2nd2004)	13720	53.4	0.1	52	196.49	1	196.49 \$/HR		12800 CY		250 CY/HR		51.2 HR		10060
Subtotal															10060
Support Personnel															
4,000 gal H2O truck Diesel (20-16) (2N04)	3350	19.85	0.1	42	84.77	1	84.77 \$/HR						32 HR		2713
Subtotal															2713
Total															36801





Ref.	Description	Materials	Means Reference Number	Unit Cost	Unit	Length
	Gob Holes New					
	Ground Preparation					
	Gouging/Pocking					
	Assume vol = area(18.1 AC) x 1 ft.	Excavation Bulk Bank 2 CY (322BL)	M023154240260		1.7 /CY	
	Seed for hydromulch	Seed Mix for Centennial Drainage	Centennial 001	447.7 \$/AC		
	Hydroseed application	Hydro Spreader (equip. & labor) B-81 80MS	Reveg002	19.13 /MSF		
	Mulch material	Hay 1" material only 029105000250	Reveg001	68 /MSF		
	Hydroseed application	Hydro Spreader (equip. & labor) B-81	Reveg005	19.13 /MSF		
	Subtotal					
	Reseeding					
	Assume 25% reseeding rate					
	Subtotal					
	Total					



Cost
5440
3582
6657
544
6657
22880
5720
5720
28600



\*\*\*\*\*CLEAN COPY\*\*\*\*\*

ANDALEX RESOURCES, INC.  
CENTENNIAL PROJECT  
007/019

AMENDMENT TO  
THE MINING AND RECLAMATION PLAN  
(APPENDIX X)

***TO ADD FIFTEEN ADDITIONAL  
GOB GAS VENT HOLES***

***CONSISTING OF:***

***PRIMARY HOLES: #10, #11, #12, #13, #14, #15, #16, & #17***

***and***

***ALTERNATE HOLES: #10A, #11A, #12A, #13A, #14A, #15A,  
& #16A***

SUBMITTED: MARCH 16, 2007

**ANDALEX RESOURCES, INC.**

**APPENDIX X**

**CENTENNIAL PROJECT  
GOB GAS VENT HOLES**

**C/007/019**

**(Revised)  
FEBRUARY 2007**

(Revised)  
FEBRUARY 2007

**CHAPTER 1**  
**LEGAL, FINANCIAL, COMPLIANCE AND**  
**RELATED INFORMATION**

## TABLE OF CONTENTS

### Section

<b>110</b>	<b>MINIMUM REQUIREMENTS FOR LEGAL, FINANCIAL, COMPLIANCE AND RELATED INFORMATION</b>	<b>1-1</b>
<b>111</b>	<b>Introduction</b>	<b>1-1</b>
<b>112</b>	<b>Identification of Interests</b>	<b>1-3</b>
	112.100 Business Entity	1-3
	112.200 Applicant and Operator	1-3
	112.300 Officers of the Applicant	1-3
	112.400 Coal Mining and Reclamation Operation Owned or Controlled	1-3
	112.500 Legal or Equitable Owner of the Surface and Mineral Properties	1-3
	112.600 Owners of Record of Property Contiguous to Proposed Permit Area	1-4
	112.700 MSHA Numbers	1-5
	112.800 Interest in Contiguous Land	1-5
	112.900 Certification of Submittal Information	1-5
<b>113</b>	<b>Violation Information</b>	<b>1-5</b>
<b>114</b>	<b>Right-of-Entry</b>	<b>1-5</b>
<b>115</b>	<b>Status of Unsuitability</b>	<b>1-7</b>
<b>116</b>	<b>Permit Term</b>	<b>1-7</b>
<b>117</b>	<b>Insurance, Proof of Publication, and Facilities and Structures Used In Common</b>	<b>1-7</b>
<b>118</b>	<b>Filing Fees</b>	<b>1-7</b>
<b>120</b>	<b>PERMIT APPLICATION FORMAT AND CONTENTS</b>	<b>1-7</b>
<b>130</b>	<b>REPORTING OF TECHNICAL DATA</b>	<b>1-7</b>
<b>140</b>	<b>MAPS AND PLANS</b>	<b>1-7</b>
<b>150</b>	<b>COMPLETENESS</b>	<b>1-7</b>



## TABLE OF CONTENTS (Continued)

### LIST OF TABLES

<b>Table 1-1</b>	Well Site Locations .....	1-2
	.....	1-2a
<b>Table 1-2</b>	Disturbed Acres by Well Site .....	1-6

### LIST OF FIGURES

<b>Figure 1-1</b>	Gob Gas Vent Hole Locations
-------------------	-----------------------------

## **110 MINIMUM REQUIREMENTS FOR LEGAL, FINANCIAL, COMPLIANCE AND RELATED INFORMATION**

### **111 Introduction**

This project is a "Ventilation Assistance Program", wherein hazardous "gob gas" from the longwall will be partially vented to the surface. The quantity and quality of the vented gas will be the same as that presently being discharged at the mine fan. The discharged "gob gas" will be of no commercial value.

Five holes have been approved and drilled in 2005. These are holes GVH#1, GVH#3, GVH#4, GVH#5 and GVH#6. Four additional holes were completed in early 2006 - GVH#5A, GVH #7, GVH #8 and GVH #9. Three additional holes were approved in late 2006 - GVH #5B, GVH #7A and GVH #8A. Of these, only 2 holes were drilled - GVH#7A and GVH#8. Due to required changes in the mining plan, hole GVH#5B will not be drilled and has been shown as eliminated, although the site has been approved and included in the bonding. GVH #7A was drilled on the existing disturbed pad area of GVH #7.

This proposal is for an additional 8 primary holes - GVH#10, GVH#11, GVH#12, GVH#13, GVH#14, GVH#15, GVH#16, and GVH#17 and 7 alternate holes - GVH#10A, GVH#11A, GVH#12A, GVH#13A, GVH#14A, GVH#15A, GVH#16A. The alternate holes would be located midway between the primary holes.

It is possible not all of the holes will be needed; however, all are proposed to be permitted in case they are needed.

The holes will be located on surface property owned by Dave R. and Mildred Cave, et al., and Mathis Land, Inc. The mineral rights are owned by Mathis Land, Inc. and the United States Government (B.L.M.) And are under lease by Andalex Resources, Inc.

The existing and proposed hole locations are described in Table 1-1 and are shown on Figure 1-1.

**TABLE 1-1**  
**Gob Gas Well Locations (see Figure 1-1)**  
**Deadman Canyon, Utah Quadrangle, Salt Lake Meridian**

Hole Number	Status	Section	Township and Range
GVH-1	Hole Completed	31	T.12S., R.11E.
GVH-3	Hole Completed	31	T.12S., R.11E.
GVH-4	Hole Completed	1	T.13S., R.10E.
GVH-5	Hole Completed	31	T.12S., R.11E.
GVH-6	Hole Completed	31	T.12S., R.11E.
GVH-5A	Hole Completed	31	T.12S., R.11E.
GVH-7, 7A*	Hole Completed	31	T.12S., R.11E.
GVH-8	Hole Completed	36	T.12S., R.10E.
GVH-9	Hole Completed	36	T.12S., R.10E.
GVH-5B	Eliminated	31	T.12S., R.11E.
GVH-8A	Hole Completed	36	T.12S., R.10E.
GVH-10	Proposed	31	T.12S., R.11E.
GVH-10A	Proposed	31	T.12S., R.11E.
GVH-11	Proposed	31	T.12S., R.11E.
GVH-11A	Proposed	31	T.12S., R.11E.
GVH-12	Proposed	31	T.12S., R.11E.
GVH-12A	Proposed	31	T.12S., R.11E.
GVH-13	Proposed	31	T.12S., R.11E.
GVH-13A	Proposed	31	T.12S., R.11E.
GVH-14	Proposed	31	T.12S., R.11E.
GVH-14A	Proposed	36	T.12S., R.10E.
GVH-15	Proposed	36	T.12S., R.10E.
GVH-15A	Proposed	36	T.12S., R.10E.
GVH-16	Proposed	36	T.12S., R.10E.
GVH-16A	Proposed	36	T.12S., R.10E.
GVH-17	Proposed	36	T.12S., R.10E.

\* Redrilled on existing pad GVH#7.

STATION	MINE COORDINATE SYSTEM (SURVEY FEET)				UTM NAD 27 (SURVEY FEET)		WGS 1984	
	NORTHING	EASTING	ELEVATION		NORTHING	EASTING	LATITUDE	LONGITUDE
GVH 1	510178.9	2218871.9	8527.4		14428218	1717912	39°43'51.5"N	110°43'30.4"W
GVH 3	510246.2	2214978.2	8510.1		14428308	1714021	39°43'52.5"N	110°44'20.2"W
GVH 4	510196.9	2212651.7	8589.2		14428273	1711697	39°43'52.2"N	110°44'50.0"W
GVH 5	511682.1	2218840.4	8463.1		14429720	1717889	39°44'06.3"N	110°43'30.6"W
GVH 5A	511717.6	2218039.0	8476.1		14429760	1717089	39°44'06.8"N	110°43'40.9"W
GVH 6	511735.7	2216541.0	8477.8		14429787	1715592	39°44'07.1"N	110°44'00.1"W
GVH 7	511708.0	2214865.8	8385.9		14429770	1713918	39°44'07.0"N	110°44'21.5"W
GVH 7A	511708.0	2214865.8	8385.9		14429770	1713918	39°44'07.0"N	110°44'21.5"W
GVH 8	511695.0	2213369.8	8453.1		14429766	1712423	39°44'07.0"N	110°44'40.6"W
GVH 8A	511680.0	2212688.7	8400.0		14429755	1711742	39°44'06.9"N	110°44'49.4"W
GVH 9	511665.0	2212007.5	8511.0		14429744	1711062	39°44'06.8"N	110°44'58.1"W
GVH 10	513232.5	2218979.4	8282.0		14431268	1718037	39°44'21.6"N	110°43'28.7"W
GVH 10A	513227.1	2218446.1			14431266	1717504		
GVH 11	513221.6	2217912.8	8358.1		14431264	1716971	39°44'21.6"N	110°43'42.3"W
GVH 11A	513213.5	2217382.1			14431259	1716441		
GVH 12	513205.3	2216851.3	8339.7		14431254	1715911	39°44'21.6"N	110°43'55.9"W
GVH 12A	513197.5	2216317.0			14431249	1715377		
GVH 13	513189.8	2215782.6	8182.6		14431245	1714843	39°44'21.5"N	110°44'09.6"W
GVH 13A	513187.5	2215252.1			14431245	1714313		
GVH 14	513185.1	2214721.5	8293.7		14431246	1713783	39°44'21.6"N	110°44'23.2"W
GVH 14A	513180.3	2214189.2			14431245	1713251		
GVH 15	513175.5	2213657.0	8337.7		14431243	1712719	39°44'21.6"N	110°44'36.8"W
GVH 15A	513171.1	2213124.4			14431242	1712187		
GVH 16	513166.7	2212591.9	8429.4		14431241	1711655	39°44'21.6"N	110°44'50.4"W
GVH 16A	513161.9	2212059.4			14431239	1711123		
GVH 17	513157.2	2211527.0	8426.7		14431238	1710591	39°44'21.6"N	110°45'04.1"W



## **112 Identification of Interests**

Refer to the same section of the approved M&RP.

### **112.100 Business Entity**

Refer to the same section of the approved M&RP.

### **112.200 Applicant and Operator**

Applicant and Operator: Andalex Resources, Inc  
Tower Division  
P.O. Box 902  
Price, Utah 84501  
Telephone: (435) 637-5385

Contact Person and  
Resident Agent: Dave Shaver  
Andalex Resources, Inc  
Tower Division  
P.O. Box 902  
Price, Utah 84501  
Telephone: (435) 637-5385

**Responsibility:** Andalex Resources, Inc. is responsible for submission of information and will pay abandoned mine reclamation fees.

### **112.300 Officers of the Applicant**

Refer to the same section of the approved M&RP.

### **112.400 Coal Mining and Reclamation Operation Owned or Controlled**

Refer to the same section of the approved M&RP.

### **112.500 Legal or Equitable Owner of the Surface and Mineral Properties**

The legal and equitable owner of the surface and mineral properties to be affected by this operation during the duration of the permit period are listed below:

Surface Owners

David R. & Mildred Cave, et al.  
144 South 1650 East  
Price, Utah 84501

Mathis Land Co.  
Sunnyside Star Route  
Price, Utah 84501

Sub-Surface Owners

United States of America  
Bureau of Land Management  
Utah State Office  
136 East South Temple  
Salt Lake City, Utah 84111

Mathis Land Co.  
Sunnyside Star Route  
Price, Utah 84501

**112.600 Owners of Record of Property Contiguous to Proposed Permit Area**

Owners of record for surface and mineral properties contiguous to the proposed permit area are listed below:

Contiguous Surface Owners

David R. & Mildred Cave, et al.  
144 South 1650 East  
Price, Utah 84501

Mathis Land Co.  
Sunnyside Star Route  
Price, Utah 84501

F. and D. Shimmin  
711 North 500 East  
Price, Utah 84501

### Contiguous Sub-Surface Owners

United States of America  
Bureau of Land Management  
Utah State Office  
136 East South Temple  
Salt Lake City, Utah 84111

State of Utah  
School Trust Lands Administration  
675 East 500 South  
Salt Lake City, Utah 84102

Mathis Land Co.  
Sunnyside Star Route  
Price, Utah 84501

### **112.700 MSHA Numbers**

Refer to the same section of the approved M&RP.

### **112.800 Interest in Contiguous Lands**

Andalex Resources, Inc. has no interest in contiguous lands other than those currently owned as shown on Plate 1A of the approved M&RP.

### **112.900 Certification of Submittal Information**

No information has changed in the approved M&RP because of this submittal. Refer to the same section of the approved M&RP.

### **113 Violation Information**

Refer to the same section in the approved M&RP.

### **114 Right-of-Entry Information**

Refer to the same section of the approved M&RP. A surface use agreement with the private surface owners is in place. A memorandum of this agreement is included in the MRP and is on record at the County Recorder's office. (See Appendix X-1)

Since each proposed well site has not been finally located or surveyed in the field, an assumed disturbance of 1.0 acres is used as an estimate for each site.

See Table 1-2 for actual disturbed acreage for each completed well site. The actual disturbed acres will be added to the total disturbed acreage for the Centennial Project as each site is constructed and surveyed.

**TABLE 1-2**  
**Disturbed Acres by Well Site**

Well Site	Status	Disturbed Acres	
		Original	Existing
GVH-1	Hole Completed	1.15	0.52
GVH-3	Hole Completed	1.11	0.55
GVH-4	Hole Completed	0.95	0.45
GVH-5	Hole Completed	0.97	0.51
GVH-6	Hole Completed	1.49	0.46
GVH-5A	Hole Completed	0.76	0.59
GVH-7, 7A	Hole Completed	0.50	0.33
GVH-8	Hole Completed	0.65	0.65
GVH-9	Hole Completed	0.81	0.81
GVH-5B	Eliminated	-	-
GVH-8A	Hole Completed	1.25	0.49
GVH-10	Proposed	-	-
GVH-10A	Proposed	-	-
GVH-11	Proposed	-	-
GVH-11A	Proposed	-	-
GVH-12	Proposed	-	-
GVH-12A	Proposed	-	-
GVH-13	Proposed	-	-
GVH-13A	Proposed	-	-
GVH-14	Proposed	-	-
GVH-14A	Proposed	-	-
GVH-15	Proposed	-	-
GVH-15A	Proposed	-	-
GVH-16	Proposed	-	-
GVH-16A	Proposed	-	-
GVH-17	Proposed	-	-

\* Redrilled on existing pad GVH#7.



## **115 Status of Unsuitability Claims**

Refer to the same section of the approved M&RP.

## **116 Permit Term**

Refer to the same section of the approved M&RP.

## **117 Insurance, Proof of Publication, and Facilities and Structures Used in Common**

The certificate of insurance(s) for each well will be obtained if required when the well is drilled. The certificate of insurance(s) will be included in Appendix B of the approved M&RP.

## **118 Filing Fees**

Refer to the same section of the approved M&RP.

## **120 PERMIT APPLICATION FORMAT AND CONTENTS**

This amendment submittal will comply with R645-301-120.

## **130 REPORTING OF TECHNICAL DATA**

All technical data submitted in the amendment will be accompanied by the name or organization responsible for the collection and analysis of data, dates of collection and descriptions of methodology used. Technical analyses will be planned by or under the direction of a qualified professional in the subject to be analyzed.

## **140 MAPS AND PLANS**

The maps and plans in the Mining and Reclamation Plan will correspond with the requirements in R645-301-140.

## **150 COMPLETENESS**

Andalex Resources, Inc. believes the information in this permit application to be complete and correct.







**FIGURE 1-1**

**GVH LOCATION MAP**

# UTAH AMERICAN ENERGY - TOWER MINE GVH LOCATIONS

10/26/2006

STATION	MINE COORDINATE SYSTEM (SURVEY FEET)			UTM NAD 27 (SURVEY FEET)		WGS 1984	
	NORTHING	EASTING	ELEVATION	NORTHING	EASTING	LATITUDE	LONGITUDE
GVH 1	510178.9	2218871.9	8527.4	14428218	1717912	39°43'51.5"N	110°43'30.4"W
GVH 3	510246.2	2214978.2	8510.1	14428308	1714021	39°43'52.5"N	110°44'20.2"W
GVH 4	510196.9	2212651.7	8589.2	14428273	1711697	39°43'52.2"N	110°44'50.0"W
GVH 5	511682.1	2218840.4	8463.1	14429720	1717889	39°44'06.3"N	110°43'30.6"W
GVH 5A	511717.6	2218039.0	8476.1	14429760	1717089	39°44'06.8"N	110°43'40.9"W
GVH 5B	511699.8	2218439.7	8400.0	14429740	1717489	39°44'06.6"N	110°43'35.8"W
GVH 6	511735.7	2216541.0	8477.8	14429787	1715592	39°44'07.1"N	110°44'00.1"W
GVH 7	511708.0	2214865.8	8385.9	14429770	1713918	39°44'07.0"N	110°44'21.5"W
GVH 7A	511708.0	2214865.8	8385.9	14429770	1713918	39°44'07.0"N	110°44'21.5"W
GVH 8	511695.0	2213369.8	8453.1	14429766	1712423	39°44'07.0"N	110°44'40.6"W
GVH 8A	511680.0	2212688.7	8400.0	14429755	1711742	39°44'06.9"N	110°44'49.4"W
GVH 9	511665.0	2212007.5	8511.0	14429744	1711062	39°44'06.8"N	110°44'58.1"W
GVH 10	513232.5	2218979.4	8282.0	14431268	1718037	39°44'21.6"N	110°43'28.7"W
GVH 10A	513227.1	2218446.1		14431266	1717504		
GVH 11	513221.6	2217912.8	8358.1	14431264	1716971	39°44'21.6"N	110°43'42.3"W
GVH 11A	513213.5	2217382.1		14431259	1716441		
GVH 12	513205.3	2216851.3	8339.7	14431254	1715911	39°44'21.6"N	110°43'55.9"W
GVH 12A	513197.5	2216317.0		14431249	1715377		
GVH 13	513189.8	2215782.6	8182.6	14431245	1714843	39°44'21.5"N	110°44'09.6"W
GVH 13A	513187.5	2215252.1		14431245	1714313		
GVH 14	513185.1	2214721.5	8293.7	14431246	1713783	39°44'21.6"N	110°44'23.2"W
GVH 14A	513180.3	2214189.2		14431245	1713251		
GVH 15	513175.5	2213657.0	8337.7	14431243	1712719	39°44'21.6"N	110°44'36.8"W
GVH 15A	513171.1	2213124.4		14431242	1712187		
GVH 16	513166.7	2212591.9	8429.4	14431241	1711655	39°44'21.6"N	110°44'50.4"W
GVH 16A	513161.9	2212059.4		14431239	1711123		
GVH 17	513157.2	2211527.0	8426.7	14431238	1710591	39°44'21.6"N	110°45'04.1"W

(Revised)  
FEBRUARY 2007

**CHAPTER 2**  
**SOILS**



## TABLE OF CONTENTS

### Section

<b>210</b>	<b>INTRODUCTION</b> .....	<b>2-1</b>
<b>220</b>	<b>ENVIRONMENTAL DESCRIPTION</b> .....	<b>2-1</b>
<b>221</b>	<b>Prime Farmland Investigation</b> .....	<b>2-1</b>
<b>222</b>	<b>Soil Survey</b> .....	<b>2-1</b>
	222.100 Soils Map .....	2-1
	222.200 Soil Identification .....	2-2
	222.300 Soil Description .....	2-2
	222.400 Soil Productivity .....	2-2
<b>223</b>	<b>Soil Characterization</b> .....	<b>2-4</b>
<b>224</b>	<b>Substitute Topsoil</b> .....	<b>2-4</b>
<b>230</b>	<b>OPERATION PLAN</b> .....	<b>2-4</b>
<b>231</b>	<b>General Requirements</b> .....	<b>2-4</b>
	231.100 Removing and Storing Topsoil Methods .....	2-4
	231.200 Suitability of Topsoil Substituted/Supplements .....	2-5
	231.300 Testing of Topsoil Handling and Reclamation Procedures Regrading Revegetation .....	2-5
	231.400 Construction, Modification, Use, and Maintenance Of Topsoil Storage Pile .....	2-5
<b>232</b>	<b>Topsoil and Subsoil Removal</b> .....	<b>2-7</b>
	232.100 Topsoil Removal and Segregation .....	2-7
	232.200 Poor Topsoil .....	2-7
	232.300 Thin Topsoil .....	2-7
	232.400 Minor Disturbances Nor Requiring Topsoil Removal .....	2-7
	232.500 Subsoil Segregation .....	2-7
	232.600 Timing .....	2-7
	232.700 Topsoil and Subsoil Removal Under Adverse Conditions ....	2-8

## TABLE OF CONTENTS (Continued)

<b><u>Section</u></b>	<b><u>Page</u></b>
<b>233 Topsoil Substitutes and Supplements</b> .....	<b>2-8</b>
233.100 Overburden Materials Supplementing and/or Replacing Topsoil .....	2-8
233.200 Suitability of Topsoil Substitutes and Supplements .....	2-8
233.300 Physical and Chemical Analysis .....	2-8
233.400 Testing of Substitute Topsoil .....	2-8
<b>234 Topsoil Storage</b> .....	<b>2-8</b>
234.100 Topsoil Stockpiling .....	2-8
234.200 Topsoil Stockpile .....	2-9
234.300 Topsoil Stockpile Relocation .....	2-9
<b>240 RECLAMATION PLAN</b> .....	<b>2-10</b>
<b>241 General Information</b> .....	<b>2-10</b>
<b>242 Soil Redistribution</b> .....	<b>2-10</b>
242.100 Soil Redistribution Practices .....	2-10
242.200 Regrading .....	2-12
242.300 Topsoil Redistribution on Impoundments and Roads .....	2-12
<b>243 Soil Nutrients and Amendments</b> .....	<b>2-12</b>
<b>244 Soil Stabilization</b> .....	<b>2-13</b>
244.100 Protection and Stabilization of Surface Area .....	2-13
244.200 Mulch Application .....	2-13
244.300 Rills and Gullies .....	2-13
<b>250 PERFORMANCE STANDARDS</b> .....	<b>2-13</b>
<b>251 Topsoil, Subsoil, and Topsoil Supplements Management</b> .....	<b>2-13</b>
<b>252 Stockpile Topsoil and Subsoil</b> .....	<b>2-13</b>

## **TABLE OF CONTENTS (Continued)**

### **LIST OF TABLES**

<b>Table 2-1 Topsoil Volumes</b> .....	<b>2-3</b>
<b>Table 2-2 Topsoil Stockpile Dimensions</b> .....	<b>2-6</b>
<b>Table 2-3 Topsoil Distribution Thickness</b> .....	<b>2-11</b>

### **LIST OF ATTACHMENTS**

<b>Attachment 2-1</b>	<b>Soil Inventory and Assessment - Approved Holes GVH-1 through GVH-9</b>
<b>Attachment 2-2</b>	<b>Soil Inventory and Assessment - Proposed Holes GVH-10 through GVH-17</b>

## **210 INTRODUCTION**

This chapter and associated attachments address the pertinent data required for the 11 existing degassification well sites for the Centennial Project (GVH#1, GVH#2, GVH#4, GVH#5, GVH#5A, GVH#6, GVH#7, GVH#8, GVH#9, GVH#7A, GVH#8A) as well as the 15 proposed additional well sites (GVH#10, GVH#10A, GVH#11, GVH#11A, GVH#12, GVH#12A, GVH#13, GVH#13A, GVH#14, GVH#14A, GVH#15, GVH#15A, GVH#16, GVH#16A, GVH#17). Only those sections of the Division regulations that apply to the well sites have been addressed. The remainder of the regulations have already been addressed in the existing M&RP. The M&RP and this document contain pertinent information relating to the identification, management, and reclamation activities associated with the soil resources.

Due to required changes in the mining plan, hole GVH#5B will not be drilled and has been shown as eliminated, although the site has been approved and included in the bonding.

## **220 ENVIRONMENTAL DESCRIPTION**

The well sites range in elevation from approximately 8400 to 8600 feet. The well sites are located in the Summit Creek/Emma Park area of the Book Cliffs. General vegetation includes sagebrush-grass, aspen and oak brush communities.

### **221 Prime Farmland Investigation**

Due to limiting terrain, lack of water for irrigation and no evidence of past cultivation of the sites, it is concluded that no prime farmland exists within the area of the well site disturbance.

### **222 Soil Survey**

#### **221.100 Soils Map**

An order 1 soil survey has been conducted of the area to help define the previous conditions at well sites 1, 3, 4, 5 and 6. This information will be used for final reclamation for these sites. An order 1 Soil Survey was also conducted for completed sites GVH#5A, GVH#7, GVH#8 and GVH#9. Results of the order 1 surveys are provided in Attachment 2-1 "Soil Inventory and Assessment" - Approved Holes GVH#1 through GVH#9. Due to the amount of soil data gathered during the order 1 surveys done for the existing nine nearby sites and the consistent nature of the soil characteristics in the area, assumptions were made about the nature of the soils at sites GVH#7A and GVH#8A. These assumptions included depth of available topsoil and quality of material.

An order 1 soil survey has also been completed for proposed primary holes GVH#10 through GVH#17. Results of this survey are included in Attachment 2-1 "Soil Inventory and Assessment - Proposed Holes GVH#10 through GVH#17". It should be noted that the soils survey was conducted on the primary holes numbers only (i.e. GVH#10, GVH#11, etc.). Each of the primary holes has an alternate or additional location proposed (i.e. GVH#10A, GVH#11A, etc.). Based on the amount of soil data gathered for the previously approved holes, as well as that for the proposed holes, and the consistent nature of the soil characteristics in the area, assumptions have been made about the nature of the soils at the alternate proposed sites. These assumptions include depth of available topsoil and quality of material. Topsoil at these alternate sites will be sampled and analyzed at the time of salvage. Results of these analyses will then be added to Attachment 2-2.

#### **222.200 Soil Identification**

See Attachment 2-1, and 2-2.

#### **222.300 Soil Description**

See Attachment 2-1, and 2-2.

#### **222.400 Soil Productivity**

See Attachment 2-1, and 2-2.



**TABLE 2-1**  
**Topsoil Volumes**

Well No.	Status	Cubic Yards of Material	
		Original	Remaining*
GVH-1	Hole Completed	2778	1250
GVH-3	Hole Completed	2689	1333
GVH-4	Hole Completed	2300	1083
GVH-5	Hole Completed	2347	1228
GVH-6	Hole Completed	3611	1111
GVH-5A	Hole Completed	1839	1389
GVH-7, 7A	Hole Completed	1210	926
GVH-8	Hole Completed	1573	1573
GVH-9	Hole Completed	1960	1960
GVH-5B	Eliminated	-	-
GVH-8A	Hole Completed	3025	1186
GVH-10	Proposed	2480	-
GVH-10A	Proposed	2400	-
GVH-11	Proposed	2480	-
GVH-11A	Proposed	2400	-
GVH-12	Proposed	807	-
GVH-12A	Proposed	2400	-
GVH-13	Proposed	2044	-
GVH-13A	Proposed	2400	-
GVH-14	Proposed	2823	-
GVH-14A	Proposed	2400	-
GVH-15	Proposed	1775	-
GVH-15A	Proposed	2400	-
GVH-16	Proposed	2346	-
GVH-16A	Proposed	2400	-
GVH-17	Proposed	2420	-

\* Remaining soil is after original pad reduction and contemporaneous reclamation.

Note: 2400 CY per Well is assumed until final surveys are done. Actual size of the pads could be less than 1 acre, in which case the volume stored will be reduced accordingly.

## **223 Soil Characterization**

See attachment 2-1, and 2-2.

## **224 Substitute Topsoil**

Andalex Resources, Inc. does not plan to use substitute topsoil as growth media unless described in Section 222.400.

## **230 OPERATION PLAN**

### **231 General Requirements**

#### **231.100 Removing and Storing Topsoil Methods**

The topsoil will be removed (and replaced) to a depth of 18 inches where the thickness exists, stockpiled and protected with a berm and/or silt fence. A qualified person will be on site during soil salvage to monitor and supervise the operation for the purpose of maximizing salvage volumes. Prior to topsoil salvage shrubs/vegetation will be removed and placed/wind rowed along the inside perimeter of the disturbed area. Stockpiled topsoil will not be allowed to remain at the angle of repose (1h:1v) for a period of longer than two weeks. During contemporaneous reclamation, or after two weeks, the stockpiled topsoil slopes will be reduced to less than 2h:1v. The topsoil will then be immediately seeded after the proper angle is achieved. Reseeding will use the approved seed mixture found in ARI's Mining and Reclamation Plan (page 3-21), or a mix recommended by the Division, and will be hand broadcast, raked in slightly and mulched with straw or alfalfa hay. Hand broadcasting requires twice the seed rate per acre as drilling.

After the topsoil is removed, the mud pit will be excavated and the soils from the mud pit excavation will be stored immediately adjacent to the mud pit. Mud pit excavation of subsoil will be approximately 110 CY at each well site. Generally, it is expected that mud pits will be excavated in an area roughly 200 square feet by 15 feet deep. A larger area is possible, should the depth not be achievable, or multiple pits may be employed. However a mud pit volume of roughly 3000 cubic feet per drill site is needed. A portable container for drilling fluids will be used if necessary, should there not be sufficient subsoil depth to excavate a mud pit (where bed rock is encountered).

Topsoil beneath the topsoil stockpiles will not be removed. Ribbon or a marking fabric will be placed on top of the topsoil prior to placement of the topsoil from the well pad area.

The volume of subsoil to be salvaged and used to create berms around the perimeter of the well including the topsoil stockpile perimeter is approximately 30 cubic yards.

#### **231.200 Suitability of Topsoil Substitutes/Supplements**

See Section 224.

#### **231.300 Testing of Topsoil Handling and Reclamation Procedures Regarding Revegetation**

Andalex Resources, Inc. will exercise care to guard against erosion during and after application of topsoil and will employ the necessary measures to ensure the stability on graded slopes. Erosion control measures will include silt fences, berms, seeding, straw bales, soil roughening, and mulching of the soils.

Topsoil will be redistributed and the original soil surface beneath the topsoil stockpile will be roughened as presented in Section 242.100 and seeded with the seed mix described in Chapter 3, Section 356.

#### **231.400 Construction, Modification, Use, and Maintenance of Topsoil Storage Pile**

Topsoil removed from the drill pad sites will be stockpiled on the site. The estimated volumes of topsoil stockpile for each site are shown in Table 2-1. The stockpiles will be sized as shown in Table 2-2.

The slopes of the stockpile will be 1H:1V or approximately 45° during the construction phase. Soils in these areas generally have an angle of repose greater than 50 degrees, making a stockpile with 1:1 slopes feasible. The steeper slope also help minimize the area to be disturbed. During the operational phase the remaining topsoil will be stockpiled with slopes of 2H:1V.

**TABLE 2-2**  
**Topsoil Stockpile Dimensions**

Well No.	Status	Length (ft)	Width (ft)	Height (ft)
GVH-1	Existing	75	40	11
GVH-3	Existing	100	40	9
GVH-4	Existing	95	35	9
GVH-5	Existing	100	35	9.5
GVH-6	Existing	105	35	8.5
GVH-5A	Existing	100	25	15
GVH-7, 7A	Existing	100	25	10
GVH-8	Existing	140	25	12
GVH-9	Existing	100	25	17.5
GVH-5B	Eliminated	-	-	-
GVH-8A	Existing	100	40	16
GVH-10	*Proposed	100	40	16
GVH-10A	*Proposed	100	40	16
GVH-11	*Proposed	100	40	16
GVH-11A	*Proposed	100	40	16
GVH-12	*Proposed	100	40	16
GVH-12A	*Proposed	100	40	16
GVH-13	*Proposed	100	40	16
GVH-13A	*Proposed	100	40	16
GVH-14	*Proposed	100	40	16
GVH-14A	*Proposed	100	40	16
GVH-15	*Proposed	100	40	16
GVH-15A	*Proposed	100	40	16
GVH-16	*Proposed	100	40	16
GVH-16A	*Proposed	100	40	16
GVH-17	*Proposed	100	40	16

\* These are approximate dimensions of the topsoil stockpile for the proposed well sites, based on the estimated CY from Table 2-1. Actual construction dimensions may vary.

See section 234.200 for detailed information on the topsoil stockpile(s).

## **232 Topsoil and Subsoil Removal**

### **232.100 Topsoil Removal and Segregation**

All topsoil will be removed as a single layer with no segregation to a depth of 18 inches, where available. Topsoil will be removed using a dozer and/or loader. Refer to Section 231.100 for additional details.

### **232.200 Poor Topsoil**

Not Anticipated

### **232.300 Thin Topsoil**

Not Anticipated

### **232.400 Minor Disturbances Not Requiring Topsoil Removal**

Not Anticipated

### **232.500 Subsoil Segregation**

The B and C soil horizons will generally not be removed. However, in drill pad locations where the A horizon is 18 inches or less, up to six inches of sub-soil may be removed for the purpose of constructing a berm around the perimeter of the drill pad. Construction of this berm, which will be roughly triangular in shape and roughly one foot in height (1V:1H), will accumulate an additional storage of either lower A or possibly B horizon soil of approximately 800 cubic feet or 30 cubic yards of material, per site.

### **232.600 Timing**

Topsoil removal will take place after all vegetation that could interfere with salvaging the topsoil has been grubbed.



## **232.700 Topsoil and Subsoil Removal Under Adverse Conditions**

The topsoil will be removed first and stockpiled and the remaining soil horizons will be left in place, except where natural conditions render removal operations hazardous or detrimental to soils outside the disturbed area then topsoil will not be removed.

**Conventional Machines** - In locations where steep grades, adverse terrains, severe rockiness, limited depth of soils, or other adverse conditions exist that render soil removal activities using conventional machines hazardous, soils will not be salvaged and stockpiled. Such conditions are not likely to occur in these areas.

**Substitute Topsoil** - Importing of substitute topsoil is not anticipated (Section 224).

## **233 Topsoil Substitutes and Supplements**

### **233.100 Overburden Materials Supplementing and/or Replacing Topsoil**

No overburden material will be used.

### **233.200 Suitability of Topsoil Substitutes and Supplements**

No substitute topsoil is planned.

### **233.300 Physical and Chemical Analyses**

See Section 243

### **233.400 Testing of Substitute Topsoil**

No substitute topsoil is planned.

## **234 Topsoil Storage**

### **234.100 Topsoil Stockpiling**

Topsoil will be stockpiled for later use in reclamation operations.

### **234.200 Topsoil Stockpile**

**Stable Stockpile Site** - Stockpiled material will be placed on a stable site.

**Protection from Contaminants and Compaction** - To protect the topsoil from contaminants and unnecessary compaction that could interfere with vegetation, the stockpile will be isolated from the main surface area by a berm and/or silt fence. A sign designating "topsoil" will be installed on the stockpile.

The topsoil stockpile will be constructed in such a manner as to allow access for repair of the pile surfaces and diversion structures.

**Wind and Water Erosion Protection** - The topsoil stockpile will be protected from water erosion by berms, which trap sediment runoff from the stockpile. The berms have been designed to completely contain the 10-year 24-hour storm event (see Attachment 7-1). The stockpile will be surface pitted, gouged and/or roughened and revegetated using the seeds listed in Table 3-2 to prevent wind erosion.

**Topsoil Redistribution** - Stockpile soil will not be moved until redistribution during contemporaneous or final reclamation operations unless approved by the Division.

### **234.300 Topsoil Stockpile Relocation**

Stockpiles soil in jeopardy of being detrimentally affected in terms of its quality by drilling operations may be temporarily redistributed or relocated on approval by the Division and modification of this M&RP.

## **240 RECLAMATION PLAN**

### **241 General Information**

Reclamation of the sites (topsoil redistribution, amendments, and stabilization) is discussed in Sections 242, 243 and 244 respectively.

### **242 Soil Redistribution**

#### **242.100 Soil Redistribution Practices**

The topsoil will be placed after recontouring of the site has occurred. Topsoil will be handled when loose or in a friable condition. The moisture content will be visually monitored and water will be added as needed to enhance the soil's condition for handling. The approximate amount of topsoil available for each site is shown in Table 2-1.

The topsoil will be distributed in two phases at each well site. The first phase will be the contemporaneous reclamation of a portion of the pad area used during well construction (see Figures 5-2). During contemporaneous reclamation topsoil from the stockpile will be distributed on each site in the depths shown in Table 2-3.

Final reclamation will occur at all well sites after venting of the gob gas is complete, venting equipment has been removed and the well has been plugged. The topsoil stockpile storage area and any access road required to be removed will be reclaimed during this final phase. If access roads were pre-existing, they will not be reclaimed. Refer to Section 341 for additional information.

**Soil Thickness** - The topsoil will be distributed during contemporaneous and final reclamation in the thickness shown in Table 2-3. (Note: A topsoil thickness of 18" is assumed for all sites until actual measurements can be taken.)

**TABLE 2-3**  
**Approximate Topsoil Distribution Thickness**

<b>Well Site No.</b>	<b>Status</b>	<b>Topsoil Thickness (inches)</b>
GVH-1	Actual	18
GVH-2	Actual	18
GVH-3	Actual	18
GVH-5	Actual	18
GVH-5A	Actual	18
GVH-6	Actual	18
GVH-7, 7A	Actual	18
GVH-8	Actual	18
GVH-9	Actual	18
GVH-5B	Eliminated	-
GVH-8A	Actual	18
GVH-10	Proposed	18
GVH-10A	Proposed	18
GVH-11	Proposed	18
GVH-11A	Proposed	18
GVH-12	Proposed	6
GVH-12A	Proposed	18
GVH-13	Proposed	22
GVH-13A	Proposed	18
GVH-14	Proposed	21
GVH-14A	Proposed	18
GVH-15	Proposed	12
GVH-15A	Proposed	18
GVH-16	Proposed	18
GVH-16A	Proposed	18
GVH-17	Proposed	18

**Compaction** - Prior to the application of topsoil, compacted subsoils will be roughened or loosened for a depth of 18 to 24 inches. To prevent compaction of topsoil, soil moving equipment will refrain from unnecessary operation over spread topsoil. The topsoil will be in a loosened condition prior to seeding.

Following the drying of the mud pit materials, the dirt excavated to create the mud pit will be mixed with the drill cutting and returned to the pit to prevent a boundary of hard material from forming in the mud pit are that would hamper root penetration and then compacted to minimize settling.

**Erosion** - Care will be exercised to ensure the stability of topsoil on graded slopes to guard against erosion during and after topsoil application. Post reclamation (contemporaneous and final) erosion control measures will be surface roughing, mulching and seeding. Out slopes along all the access roads will be seeded with a fast growing type of seed, western wheatgrass grass for example. This will quickly establish an erosion control measure on the out slopes.

#### **242.200 Regrading**

The areas will be graded to their approximated original topographic configuration.

#### **242.300 Topsoil Redistribution on Impoundments and Roads**

The mud pits will be dismantled and filled following completion of drilling. See Section 242.100, Compaction for additional information. Mud pits will be covered with the same amount of topsoil as the rest of the site. The roads existing prior to starting the drilling program will not be reclaimed. Access roads built to allow entrance to the drilling pads will be reclaimed and will receive topsoil in the same depth as their corresponding pad areas when gob gas venting is complete.

### **243 Soil Nutrients and Amendments**

The soils will be analyzed directly following salvage to determine if amendments are needed. Testing of the topsoil will be done according to Table 6 of the Division's Topsoil and Overburden Guidelines. The topsoil will be tested at a minimum for the following parameters: Texture, pH, electrical conductivity, total carbon, SAR, water holding capacity, plant available nitrogen, and phosphorus. Results of these analyses will be incorporated into Attachment 2-2.



## **244 Soil Stabilization**

### **244.100 Protection and Stabilization of Surface Area**

All reclaimed areas will be stabilized to control erosion by application of mulch, tackifier, and roughening of the surface. The areas will be graded to the approximately original topographic configuration. Seeding will be accomplished with the application of seeds and mulch with a long fiber tackifier or broadcast. Methods of protection and stabilization are further discussed in Chapter 3, Section 341.

### **244.200 Mulch Application**

Mulch/tackifier will be applied to stabilize the soil on all areas that have been regraded and covered with growth media. For further discussion of revegetation practices to be utilized, see Chapter 3, Section 341.

### **244.300 Rills and Gullies**

**Postmining Land Use and Revegetation** - Rills and gullies that are approximately nine (9) inches in depth and disrupt the postmining land use or reestablishment of vegetative cover will be regraded and seeded.

**Water Quality** - There are no streams immediately adjacent to the well sites.

## **250 PERFORMANCE STANDARDS**

### **251 Topsoil, Subsoil, and Topsoil Supplements Management**

All topsoil, subsoil, and topsoil supplements will be managed as outlined in Sections 230 and 240.

### **252 Stockpiled Topsoil and Subsoil**

All stockpiled topsoil and subsoil will be managed according to plans outlined in Sections 230 and 240.

**Soil Inventory and Assessment  
Gas Ventilation Borehole Sites  
GVH 5A, 7, 8, and 9  
Aberdeen Mine  
Carbon County, Utah**

**Prepared For:**

**Andalex Resources, Inc.  
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**Prepared By:**

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**December 2005**

**Andalex Resources, Inc.**  
**Soil Inventory and Assessment**  
**Gas Ventilation Borehole Sites GVH 5A, 7, 8, and 9**  
**Aberdeen Mine**

**TABLE OF CONTENTS**

**INTRODUCTION**

**SETTING**

**BACKGROUND SOILS INFORMATION**

**DRILL SITE SOIL RESOURCES**

**GVH 5A**

**GVH 7**

**GVH 8**

**GVH 9**

**SOIL TESTING RESULTS**

**SUITABILITY ASSESSMENT**

**SITE SKETCHES**

**SOIL DESCRIPTIONS**

**PHOTOGRAPHS**

# **Andalex Resources, Inc.**

## **Soil Inventory and Assessment**

### **Gas Ventilation Borehole Sites GVH 5A, 7, 8, and 9**

#### **Aberdeen Mine**

#### **INTRODUCTION**

This soil inventory and assessment was conducted by Daniel M. Larsen, Soil Scientist, Environmental Industrial Services, for Andalex Resources, Inc. The project consists of four gas ventilation borehole sites above the Aberdeen Mine located about 15 miles northeast of Price, Utah. Each drill site is about one acre in size and marked with a stake at the center. The sites are identified as GVH 5A, GVH 7, GVH 8, and GVH 9. They are located in Section (Sec.) 31, Township (T.) 12 South (S), Range (R.) 10 East (E) and Sec. 36, T.12S, R.11E.

The objective was to determine the characteristics of the soil resources and assess the suitability for reclamation at each site. Soil limitations and specific management concerns were to be noted. Specifically, the amount of soil to be salvaged as topsoil was to be identified, including the thickness and distribution at each site. Subsoils and underlying materials were also to be evaluated for potential salvage, segregation from topsoil, and limitations as plant growth material.

Topsoil, in the general sense, is considered as the dark colored (mollic) surface soil layer for this project area. It includes the A-horizon and suitable dark colored B-horizon soils. Some of the B-horizons are similar to the dark colored A-horizons but often show an increase in clay and have a more blocky structure.

#### **SETTING**

The drill sites are located at about 8,300 to 8,500 feet in elevation on a general northwest back slope of the Book Cliffs. Slopes at the sites range from about 5 to 10 percent gradient. The general vegetation consists of sagebrush openings with patches and strips of aspen. Annual precipitation is about 18 to 20 inches.

Soil parent materials are composed of sandstone and shale (clay layer).

The area is at the transition of frigid and cryic soil temperature régimes. Where aspen is present it is clearly cryic, but in the openings it is either frigid or cryic.

## PROCEDURES

Fieldwork was conducted on October 10, 2005. A total of 17 backhoe pits were excavated at the four sites. A pit was located near each center stake, along with four to five additional pits within each 200 X 200 foot drill site area. Some spot-checking was also done by use of a soil spade.

Soil descriptions, photographs, soil samples, and notes were obtained at each site. A full soil description and soils samples were taken at each soil pit located near the center of the sites. Soil samples were identified by the drill site numbers (GVH 5A, 7, 8, and 9) and the depth interval that the sample was taken. These were primarily from the central soil pit, Pit No.1, at each site. Two additional soil samples were obtained where suitable soil extended to greater depths in outlying soil pits than was present at the representative soil pit at the center.

The soil samples each consisted of about six pounds of soil and were collected in one gallon size plastic freezer bags. A small portion of each sample was used to determine soil colors, texture by feel, plasticity, and reaction. The remainder was sent to Inter-Mountain Laboratories, Inc., Sheridan, Wyoming for analysis of parameters required by the Utah State Division of Oil, Gas, and Mining.

## BACKGROUND SOILS INFORMATION

The area is included in the Soil Survey of the Carbon Area, Utah issued in June 1988 by the Soil Conservation Service. This is general soil survey information intended for planning purposes and is given here as background reference to tier more detailed information.

**Table 1: Soil Map Units of the Carbon Area Soil Survey:**

Site	Map Unit	Description
GVH 5A	117	Trag - Beje - Senchert Complex
GVH 7	105	Senchert Family - Senchert Complex
GVH 8	63	Midfork Family - Podo Association
GVH 9	7	Beje - Trag Complex

### Classification:

Trag	Fine-loamy, mixed, Typic Argiborolls
Beje	Loamy, mixed, Lithic Argiborolls
Senchert	Fine-loamy, mixed, Pachic Argicryolls
Midfork	Loamy-skeletal, mixed, Typic Haplocryolls
Podo	Loamy, mixed, calcareous, frigid Lithic Ustorthents

## DRILL SITE SOIL RESOURCES

Some general features apply to the soils in the project area. They have all formed from sandstone and shale and are well drained. The surface soils are dark colored and commonly have



loam and clay loam textures. The percentage of very fine sand is the major portion of the total sand fraction, giving the loam textures characteristics similar to silt loam and the clay loam textures characteristics similar to silty clay loam. The upper 3 to 5 inch layer typically has fine granular structure. The soil then changes to a more blocky structure, although the color remains about the same as the upper 5 inches. An increase in clay with depth coincides with stronger and larger blocky structure. The dark colored soil includes both A and B-horizon materials. Lighter brown subsoils are patchy and thin over very stony and/or clayey substrata. Sandstone and clay layers are commonly at about 24 to 40 inches in depth. The soils have moderate to moderately slow permeability and have moderate erodibility. The clayey substrata is slowly permeable.

**Table 2:**  
**Summary of Topsoil Available at Gas Ventilation Drill Sites (over a 200X200 foot pad site)**

Site	Representative Topsoil	Range in Thickness	Average	Depth Determining Factor	Approx. volume (cu. yds.)
GVH 5A	Very dark grayish brown loam and clay loam. Low rock fragment content	14-24	20	High rock fragment content, bedrock, or clay.	2470
GVH 7	Very dark grayish brown and dark brown loam and clay loam. Low rock fragment content	24-30	26	High rock fragment content	3210
GVH 8	Nearly black to very dark grayish brown clay loam. About 20 to 35 percent rock fragments (Gr, Co, ST).	8-32	20	Very high rock content, bedrock, and/or clay	2470 (including rock fragments)
GVH 9	Very dark grayish brown and dark brown loam and clay loam silt loam and silty clay loam. Mostly low rock fragment content. Up to 40 percent rock fragment in spots on north side.	12-36	22	Heavy, dense, clay	2716

### **GVH 5A**

This site has soils which range from about 14 to 40 inches over sandstone bedrock. Dark colored topsoils are 14 to 24 inches thick. The site averages about 20 inches of salvageable topsoil.

The thinner soils (14 to 18 inches) are along the southern third of the site where the vegetation is mostly grass compared to dense sagebrush over most of the site.

Surface soils are very dark grayish brown loam grading to clay loam. Subsoils consist of both clayey layers (shale) and stony sandstone layers. The clay layer is discontinuous as noted in the soil pits, but may be present at greater depths below sandstone lenses where it was not observed.

The typical soils are similar to the Senchert soil family. These soils classify as fine loamy, mixed, Pachic Argicryolls. Inclusions consist of soils less than 20 inches to bedrock, soils with thinner dark colored surface layers, and soils with higher rock fragment content.

#### **GVH 7**

This site supports a dense sagebrush stand has thick dark colored loam to clay loam surface soils. Subsoils are also loam to clay loam but have with an increase in rock fragments over sandstone bedrock, which is at about 30 to 40 inches in depth. The upper 24 to 30 inches has about 5 to 10 percent rock fragments while the lower part of the soil profile has about 30 to 50 percent above the bedrock.

This site is similar to GVH 5A but has a thicker dark colored surface layer, deeper soils, and less clay in the subsoil and substrata.

The soils are fine loamy to fine silty, mixed, superactive Pachic Haploborolls.

#### **GVH 8**

This site is in an aspen stand on a 10 percent slope. It is on a slight convex knoll having a northwest aspect. The surface is relatively stone free, however, the soils have gravel to boulder sized rock fragments. Surface soils are very dark colored loam to clay loam. Underlying materials consist of sandstone and clay layers.

Topsoils are generally 18 to 30 inches thick. On the northwest corner only 8 to 15 inches of dark colored soil was present over a very stony layer. The soils are similar to Midfork (loamy-skeletal, mixed, Typic Haplocryolls) and Senchert (fine-loamy, mixed, Pachic Argicryolls).

#### **GVH 9**

This site is located in a sagebrush opening along a slight ridge with a shallow dip along the south half and a higher spot along the north edge. The soils are relatively stone free except for stony spots along the north side of the site. The soils typically have a dark colored loam to clay loam surface layer that is about 19 to 30 inches thick over lighter colored clay. The clay substrate is extremely hard when dry, very firm moist, and very sticky when wet.

### **SOIL TESTING RESULTS**

Soil testing results are presented in the "Soil Analysis Report" tables submitted by Inter-Mountain Laboratories, Inc. An additional copy has been prepared showing data and interpretation notes.

A significant factor from the soil testing is showing the high amount of very fine sand in the sand fraction in particle size analysis of most of the samples. Very fine sand is similar to silt and is generally grouped with silt for interpretations and classification. The upper 6 to 9 inches of soil at each site had percentages of silt plus very fine sand of about 54 to 70 percent. Although these soils are noted as having a texture of loam they are more like silt loam for interpretations. The soils noted as clay loam on the soil analysis report are also high in very fine sand and are more like silty clay loam.

Soil reaction ranged from 6.5 to 8.1, which is considered good for plant growth. One sample, GVH8, 0 to 6 inches, had a high saturation percentage which appears to be related to the highest organic matter content; identified at 6.6 percent organic matter.

EC (electrical conductivity) ranged from 0.19 to 0.64 dS/M. These values are all less than 4.0, so would be rated as good.

Calcium carbonate equivalent was high in sample GVH8, 37 to 65 inches. This soil sample had calcium carbonate equivalent of 19.6 percent. All other soil samples ranged from 0.6 to 3.4 percent.

## **SUITABILITY ASSESSMENT**

Suitability assessment is based on guidelines from the Utah State Division of Oil, Gas and Mining (Table 4, January 2003). The sites have identifiable topsoils of a dark color (mollic) typical of what would be considered topsoil. These dark colored soils would rate good to fair. Soil texture of clay loam, which is common in the lower portion of the topsoil layer, would give the soil a rating of fair; while loam is rated as good. A K-factor greater than 0.37 is considered poor. Some of the soils may rate as fair based on a K-factor of 0.37 however none of the soils are expected to have a higher value (poor).

Underlying materials would rate as poor to unacceptable based on high rock fragment content or high clay content.

**Soil Samples for Andalex Resources, Inc.  
Gas Ventilation Borehole Sites  
October 10, 2005  
Aberdeen Mine, Carbon County, Utah**

1	GVH 5A	0-9 inches
2	GVH 5A	9-19 inches
3	GVH 5A	26-36 inches
4	GVH 5A	24-33 inches (Pit 3)
5	GVH 7	0-6 inches
6	GVH 7	6-12 inches
7	GVH 7	12-24 inches
8	GVH 7	24-33 inches
9	GVH 8	0-6 inches
10	GVH 8	6-18 inches
11	GVH 8	18-32 inches
12	GVH 8	37-65 inches
13	GVH 9	0-9 inches
14	GVH 9	9-21 inches
15	GVH 9	22-36 inches
16	GVH 9	22-38 inches (Pit 4)

**Field Soil Profile Description Notations**

This is a guide to assist in understanding the notations on the soil description forms. These are not all inclusive but are meant to apply to common situations in the mountains and foothills of central Utah.

**Horizon:** Standard letter designations used for soil layers. Commonly used designations are:

- A Surface layer usually of dark color due to accumulation of organic matter; topsoil.
- B Altered soil layer, often associated with subsoil.
  - BT – Increase in clay
  - BK – Increase in carbonates
  - BW – Color or structure change
- C Relatively unaltered parent materials from which the soils have formed.
- R Hard bedrock; as sandstone
- CR Soft bedrock; as shale

A "B" horizon may have dark colors and have high to moderate amounts of organic matter but be designated as a "B" horizon due to soil changes as noted above.

**Depth:** Depth interval of the soil layer. Usually expressed in inches unless noted otherwise.

**Color:** Dry and moist odors are based on the Munsell Soil Color Chart and give the hue, value, and chroma. Connotative color descriptions may be added.

Texture: Texture and texture modifier abbreviations

S	Sand	SCL	Sandy	CB	Cobbly	GR	Gravelly
LS	Loamy Sand	CL	Clay Loam	CBV	Very Cobbly	GRV	Very Gravelly
SL	Sandy Loam	SICL	Silty Clay Loam	CBX	Extremely Cobbly	GRX	Extremely Gravel
L	Loam	SIC	Silty Clay	CN	Channery	SH	Shaley
SIL	Silt Loam	C	Clay	CNV	Very Channery		
SI	Silt			CNX	Extremely Channery		

Structure:	<u>Grade</u>	<u>Size</u>	<u>Type</u>
	W Weak	VF Very Fine	PL Platy
	M Moderate	F Fine	GR Granular
	S Strong	M Medium	SBK Subangular Blocky
		CO Coarse	ABK Angular Blocky
		VCO Very Course	PR Prismatic
			W Weak Massive
			S Strong Massive
			SG Single Grained

Consistency:	<u>Dry</u>	<u>Moist</u>	<u>Wet</u>
	LO Loose	LO Loose	NS Non Sticky
	SO Soft	VFR Very Friable	SS Slightly Sticky
	SH Slightly Hard	FR Friable	S Sticky
	H Hard	FI Firm	VS Very Sticky
	VH Very Hard	VFI Very Firm	NP Non Plastic
	EH Extremely Hard	EFI Extremely Firm	SP Slightly Plastic
			P Plastic
			VP Very Plastic

Reaction:	<u>Effervescence (10% HCL)</u>	<u>pH</u>	<u>Reaction Class</u>
		5.1 – 5.5	Strongly Acid
		5.6 – 6.0	Moderately Acid
EO	Non-Effervescent	6.1 – 6.5	Slightly Acid
SE	Slightly Effervescent	6.6 – 7.3	Neutral
EM	Moderately Effervescent	7.4 – 7.8	Mildly Alkaline
ES	Strongly Effervescent	7.9 – 8.4	Moderately Alkaline
EV	Violently Effervescent	8.5 – 9.0	Strongly Alkaline
		> 9.0	Very Strongly Alkaline

Horizon Boundaries:

<u>Distinctness</u>	<u>Topography</u>
A Abrupt (<2 cm thick)	S Smooth (the boundary is a plane with few or no irregularities)
C Clear (2 to 5 cm thick)	W Wavy (the boundary has undulations in which depressions are wider than they are deep).
G Gradual (5 to 15 cm thick)	I Irregular (the boundary has pockets that are deeper than they are wide)
D Diffuse (>15 cm thick)	B Broken (at least one of the horizons or layers separated by the Boundary is discontinuous and the boundary is interrupted).



Rock Fragments: Expressed in percent by volume by size.

GR	Gravel	BL	Boulders
CB	Cobbles	CN	Channers
ST	Stones	FL	Flagstone

Roots: Roots are described in terms of quantity and size. Quantity is given first followed by the size class.

<u>Quantity</u>		<u>Size</u>	
F	Few	VF	Very Fine
C	Common	F	Fine
M	Many	M	Medium
		CO	Course

Quantity classes of roots are defined in terms of numbers of each size per unit area. One (1) square centimeter for very fine and fine roots and one (1) square decimeter for medium and coarse roots.

Few: Less than 1 per unit area of the specified size  
Common: 1 to 5 per unit area of the specified size  
Many: more than 5 per unit area of the specified size

The size classes are:

Very Fine: Less than 1 mm in diameter  
Fine: 1 to 2 mm in diameter  
Medium: 2 to 5 mm in diameter  
Coarse: 5 mm or larger in diameter  
Roots larger than 10 mm in diameter may be described separately.

SOIL ANALYSIS REPORT

**Soil Analysis Report**  
**Environmental Industrial Services**

31 North Main Street  
Helper, UT 84526

Client Project ID: Andalex Res/Gas

Set #0105S09795

Date Received: 10/17/05

Report Date: 11/11/05

Lab Id	Sample Id	Depths (Inches)	pH s.u.	Saturation		EC @ 25°C dS/m	Calcium meq/L	Magnesium meq/L	Sodium meq/L	Potassium meq/L	SAR
				%							
105S09795	1-GVH5A	0 - 9	6.5	54.4		0.50	3.33	0.69	0.16	0.42	0.11
105S09796	2-GVH5A	9 - 19	6.6	43.6		0.31	2.06	0.47	0.14	0.15	0.12
105S09797	3-GVH5A	26 - 36	7.0	45.3		0.24	1.02	0.46	0.37	0.08	0.44
105S09798	4-GVH5A	24 - 33 p3	6.5	36.4		0.25	1.20	0.40	0.42	0.10	0.47
105S09799	5-GVH7	0 - 6	7.3	53.6		0.48	3.30	0.41	0.19	0.50	0.14
105S09800	6-GVH7	6 - 12	7.2	55.4		0.61	4.80	0.48	0.11	0.46	0.06
105S09801	7-GVH7	12 - 24	7.0	46.0		0.64	4.97	0.48	0.13	0.37	0.08
105S09802	8-GVH7	24 - 33	7.4	41.9		0.25	1.95	0.27	0.11	0.04	0.10
105S09803	9-GVH8	0 - 6	7.0	58.7		0.43	2.75	0.99	0.24	0.22	0.18
105S09804	10-GVH8	6 - 18	7.2	45.5		0.29	1.70	0.65	0.19	0.10	0.18
105S09805	11-GVH8	18 - 32	7.4	45.8		0.27	1.65	0.66	0.21	0.08	0.19
105S09806	12-GVH8	37 - 65	8.1	44.3		0.20	0.93	0.47	0.21	0.02	0.25
105S09807	13-GVH9	0 - 9	7.0	44.2		0.34	2.26	0.49	0.07	0.17	0.06
105S09808	14-GVH9	9 - 21	8.1	44.2		0.22	1.21	0.53	0.13	0.05	0.14
105S09809	15-GVH9	22 - 36	7.1	53.2		0.19	0.86	0.43	0.31	0.04	0.38
105S09810	16-GVH9	22 - 38 p4	6.9	46.6		0.24	1.49	0.50	0.11	0.08	0.11

These results only apply to the samples tested.

Abbreviations for extractants: PE= Saturated Paste Extract, H2Osol= water soluble, AB-DTPA= Ammonium Bicarbonate-DTPA, AAO= Acid Ammonium Oxalate

Abbreviations used in acid base accounting: T.S.= Total Sulfur, AB= Acid Base, ABP= Acid Base Potential, PyrS= Pyritic Sulfur, Pyr+Org= Pyritic Sulfur + Organic Sulfur, Neut. Pot.= Neutralization Potential

Miscellaneous Abbreviations: SAR= Sodium Adsorption Ratio, CEC= Cation Exchange Capacity, ESP= Exchangeable Sodium Percentage

Reviewed By: Joy Shulley  
Intermountain Laboratories, Inc.

Report ID: 010509795

# Soil Analysis Report

## Environmental Industrial Services

Page 1 of 4

Client Project ID: Andalex Res/Gas

**Helper, UT 84526**

Set #0105S09795

Date Received: 10/17/05

Report Date: 11/11/05

Lab Id	Sample Id	Depths (Inches)	pH s.u.	Saturation %	EC				SAR	Overall Rating	
					@ 25°C dS/m	Calcium meq/L	Magnesium meq/L	Sodium meq/L			Potassium meq/L
05S09795	1-GVH5A	0 - 9	6.5	54.4	0.50	3.33	0.69	0.16	0.42	0.11	G
05S09796	2-GVH5A	9 - 19	6.6	43.6	0.31	2.06	0.47	0.14	0.15	0.12	F cl Texture
05S09797	3-GVH5A	26 - 36	7.0	45.3	0.24	1.02	0.46	0.37	0.08	0.44	P sic Texture
05S09798	4-GVH5A	24 - 33 p3	6.5	36.4	0.25	1.20	0.40	0.42	0.10	0.47	G
05S09799	5-GVH7	0 - 6	7.3	53.6	0.48	3.30	0.41	0.19	0.50	0.14	F cl Texture
05S09800	6-GVH7	6 - 12	7.2	55.4	0.61	4.80	0.48	0.11	0.46	0.06	F cl Texture
05S09801	7-GVH7	12 - 24	7.0	46.0	0.64	4.97	0.48	0.13	0.37	0.08	G
05S09802	8-GVH7	24 - 33	7.4	41.9	0.25	1.95	0.27	0.11	0.04	0.10	F cl Texture
05S09803	9-GVH8	0 - 6	7.0	58.7 Fair	0.43	2.75	0.99	0.24	0.22	0.18	F High Saturation
05S09804	10-GVH8	6 - 18	7.2	45.5	0.29	1.70	0.65	0.19	0.10	0.18	F cl Texture
05S09805	11-GVH8	18 - 32	7.4	45.8	0.27	1.65	0.66	0.21	0.08	0.19	F cl Texture
05S09806	12-GVH8	37 - 65	8.1	44.3	0.20	0.93	0.47	0.21	0.02	0.25	P-F C Texture; high carbonate
05S09807	13-GVH9	0 - 9	7.0	44.2	0.34	2.26	0.49	0.07	0.17	0.06	G
05S09808	14-GVH9	9 - 21	8.1	44.2	0.22	1.21	0.53	0.13	0.05	0.14	F cl Texture
05S09809	15-GVH9	22 - 36	7.1	53.2	0.19	0.86	0.43	0.31	0.04	0.38	P C Texture
05S09810	16-GVH9	22 - 38 p4	6.9	46.6	0.24	1.49	0.50	0.11	0.08	0.11	F cl Texture

6.570 3.420 0.1920  
8.1 58.4 0.64  
all food all food all  
all food < 1 cent 1.4  
Brewer 14.60% 6.66%  
6.5 + 8.2

0.067  
0.44  
all in  
e < 4

**These results only apply to the samples tested.**

Abbreviations for extractants: PE= Saturated Paste Extract, H2OSol= water soluble, AB-DTPA= Ammonium Bicarbonate-DTPA, AAO= Acid Ammonium Oxalate  
Abbreviations used in acid base accounting: T.S.= Total Sulfur, AB= Acid Base, ABP= Acid Base Potential, PyrS= Pyritic Sulfur, Pyr+Org= Pyritic Sulfur + Organic Sulfur, Neut. Pot.= Neutralization Potential  
Miscellaneous Abbreviations: SAR= Sodium Adsorption Ratio, CEC= Cation Exchange Capacity, ESP= Exchangeable Sodium Percentage

Reviewed By: Joey Shurley

Joey Chodas, Cello 1 at Cincinnati

Report ID: 010509795

1633 Terra Avenue  
Sheridan, WY 82801Soil Analysis Report  
Environmental Industrial Services

Page 2 of 4

Client Project ID: Andalex Res/Gas

31 North Main Street  
Helper, UT 84526

Set #0105S09795

Date Received: 10/17/05

Report Date: 11/11/05

Lab Id	Sample Id	Depths (Inches)	Sand %	Silt %	Clay %	Texture	Very Fine Sand %	Nitrogen Nitrate ppm	Available Potassium ppm	Available Phosphorus ppm	Organic Matter %	CO3 Equivalent %
105S09795	1-GVH5A	0 - 9	49.0	31.0	20.0	LOAM	36.7	<0.02	389	28.7	5.6	0.7
105S09796	2-GVH5A	9 - 19	34.0	38.0	28.0	CLAY LOAM	19.7	<0.02	239	14.8	2.3	0.6
105S09797	3-GVH5A	26 - 36	18.0	42.0	40.0	SILTY CLAY	14.5	0.14	104	9.03	0.9	0.8
105S09798	4-GVH5A	24 - 33 p3	43.0	35.0	22.0	LOAM	18.4	<0.02	201	19.6	1.6	0.6
105S09799	5-GVH7	0 - 6	31.0	35.0	34.0	CLAY LOAM	18.5	<0.02	562	42.8	3.3	3.4
105S09800	6-GVH7	6 - 12	28.0	39.0	33.0	CLAY LOAM	19.7	0.68	461	7.30	4.2	2.6
105S09801	7-GVH7	12 - 24	31.0	47.0	22.0	LOAM	22.0	0.02	345	44.9	3.9	0.9
105S09802	8-GVH7	24 - 33	29.0	44.0	27.0	CLAY LOAM	20.6	<0.02	166	50.6	1.5	0.8
105S09803	9-GVH8	0 - 6	39.0	37.0	24.0	LOAM	21.9	0.02	314	49.5	6.6	1.0
105S09804	10-GVH8	6 - 18	38.0	32.0	30.0	CLAY LOAM	19.1	<0.02	246	54.7	3.5	0.8
105S09805	11-GVH8	18 - 32	39.0	31.0	30.0	CLAY LOAM	16.6	0.72	198	8.73	2.9	0.8
105S09806	12-GVH8	37 - 65	14.0	38.0	48.0	CLAY	8.9	1.38	81.0	1.36	0.5	19.6
105S09807	13-GVH9	0 - 9	34.0	44.0	22.0	LOAM	26.2	<0.02	291	52.2	3.9	0.8
105S09808	14-GVH9	9 - 21	28.0	40.0	32.0	CLAY LOAM	21.5	<0.02	194	6.38	2.0	0.6
105S09809	15-GVH9	22 - 36	19.0	29.0	52.0	CLAY	13.5	<0.02	140	1.96	0.7	0.9
105S09810	16-GVH9	22 - 38 p4	26.0	40.0	34.0	CLAY LOAM	20.1	<0.02	237	50.6	2.4	0.7

These results only apply to the samples tested.

Abbreviations for extractants: PE= Saturated Paste Extract, H2OSol= water soluble, AB-DTPA= Ammonium Bicarbonate-DTPA, AAO= Acid Ammonium Oxalate

Abbreviations used in acid base accounting: T.S.= Total Sulfur, AB= Acid Base, ABP= Acid Base Potential, PyrS= Pyritic Sulfur, Pyr+Org= Pyritic Sulfur + Organic Sulfur, Neut. Pot.= Neutralization Potential

Miscellaneous Abbreviations: SAR= Sodium Adsorption Ratio, CEC= Cation Exchange Capacity, ESP= Exchangeable Sodium Percentage

Reviewed By:



Jerry Shirley, Sales Lab Supervisor

## Soil Analysis Report

## Environmental Industrial Services

31 North Main Street

Helper, UT 84526

Client Project ID: Andalex Res/Gas

Date Received: 10/17/05

Page 2 of 4

Set #0105S09795

Report Date: 11/11/05

Lab ID	Sample ID	Depths (Inches)	Sand %	Silt %	Clay %	Texture	Very Fine Sand %	Nitrogen Nitrate ppm	Available Potassium ppm	Available Phosphorus ppm	Organic Matter %	CO <sub>3</sub> Equivalent %	Particle Size
5S09795	1-GVH5A	0-9	49.0	12.3	31.0	LOAM	36.7	67.7	<0.02	389	28.7	0.7	Fine silty
5S09796	2-GVH5A	9-19	34.0	14.3	38.0	CLAY LOAM	19.7	97.7	<0.02	239	14.8	0.6	Fine silty
5S09797	3-GVH5A	26-36	18.0	3.5	42.0	SILTY CLAY	14.5	56.5	0.14	104	9.03	0.8	clayey (fine)
5S09798	4-GVH5A	24-33 p3	43.0	24.6	35.0	LOAM	18.4	53.4	<0.02	201	19.6	0.6	Fine loamy
5S09799	5-GVH7	0-6	31.0	12.5	35.0	CLAY LOAM	18.5	53.5	<0.02	562	42.8	3.4	Fine loamy
5S09800	6-GVH7	6-12	28.0	8.3	39.0	CLAY LOAM	19.7	58.7	0.68	461	7.30	2.6	Fine silty
5S09801	7-GVH7	12-24	31.0	9.0	47.0	LOAM	22.0	69.0	0.02	345	44.9	0.9	Fine silty
5S09802	8-GVH7	24-33	29.0	8.4	44.0	CLAY LOAM	20.6	64.6	<0.02	166	50.6	0.8	Fine silty
5S09803	9-GVH8	0-6	39.0	17.1	37.0	LOAM	21.9	58.9	0.02	314	49.5	1.0	Fine loamy
5S09804	10-GVH8	6-18	38.0	18.9	32.0	CLAY LOAM	19.1	51.1	<0.02	246	54.7	0.8	Fine loamy
5S09805	11-GVH8	18-32	39.0	22.4	31.0	CLAY LOAM	16.6	47.6	0.72	198	8.73	0.8	Fine loamy
5S09806	12-GVH8	37-65	14.0	5.1	38.0	CLAY	8.9	46.9	1.38	81.0	1.36	19.6	clayey (fine)
5S09807	13-GVH9	0-9	34.0	7.8	44.0	LOAM	26.2	70.2	<0.02	291	52.2	0.8	Fine silty
5S09808	14-GVH9	9-21	28.0	6.5	40.0	CLAY LOAM	21.5	61.5	<0.02	194	6.38	0.6	Fine silty
5S09809	15-GVH9	22-36	19.0	5.5	29.0	CLAY	13.5	32.5	<0.02	140	1.96	0.9	clayey (fine)
5S09810	16-GVH9	22-38 p4	26.0	5.9	40.0	CLAY LOAM	20.1	60.1	<0.02	237	50.6	0.7	Fine silty

Loam C-  
CL F-  
C P  
SIC P

\* High O.M.  
Volatiles to 200°C  
with solvent  
permeant

0.6 C<sub>0</sub>  
19.6

4/5 C

Water-soluble  
nutrients  
67.7% 9.4% 12.3% 3.5%  
pH 5.1

These results only apply to the samples tested.

Abbreviations for extractants: PE= Saturated Paste Extract, H2Osol= water soluble, AB-DTPA= Ammonium Bicarbonate-DTPA, AAO= Acid Ammonium Oxalate

Abbreviations used in acid base accounting: T.S.= Total Sulfur, AB= Acid Base, ABP= Acid Base Potential, Pyrs= Pyritic Sulfur, Pyr+Org= Pyritic Sulfur + Organic Sulfur, Neut. Pot.= Neutralization Potential

Abbreviations: SAR= Sodium Adsorption Ratio, CEC= Cation Exchange Capacity, ESP= Exchangeable Sodium Percentage

Reviewed By:

Jerry Shirley

Interpretation: Soils 1 and 2 are non-saline



Report ID: 010509795

**Soil Analysis Report**  
**Environmental Industrial Services**

Page 3 of 4

Client Project ID: Andalex Res/Gas

31 North Main Street  
Helper, UT 84526

Set #0105S09795

Date Received: 10/17/05

Report Date: 11/11/05

Lab Id	Sample Id	Depths (Inches)	pH s.u.	Saturation %	EC		Calcium meq/L	Magnesium meq/L	Sodium meq/L	Potassium meq/L	SAR
					@ 25°C dS/m						
105S09803	9-GVH8	0 - 6	7.0	58.7	0.43		2.75	0.99	0.24	0.22	0.18
105S09803D	9-GVH8	0 - 6	7.0	60.9	0.44		2.83	1.04	0.19	0.25	0.14
105S09809	15-GVH9	22 - 36	7.1	53.2	0.19		0.86	0.43	0.31	0.04	0.38
105S09809D	15-GVH9	22 - 36	7.2	53.6	0.21		1.06	0.54	0.30	0.03	0.34

These results only apply to the samples tested.

Abbreviations for extractants: PE= Saturated Paste Extract, H2OSol= water soluble, AB-DTPA= Ammonium Bicarbonate-DTPA, AAO= Acid Ammonium Oxalate  
Abbreviations used in acid base accounting: T.S.= Total Sulfur, AB= Acid Base, ABP= Acid Base Potential, PyrS= Pyritic Sulfur, Pyr+Org= Pyritic Sulfur + Organic Sulfur, Neut. Pot.= Neutralization Potential  
Miscellaneous Abbreviations: SAR= Sodium Adsorption Ratio, CEC= Cation Exchange Capacity, ESP= Exchangeable Sodium Percentage

Reviewed By: Jerry Shirley  
Inari Chandra, Sales & Customer Service

Report ID: 010509795

1633 Terra Avenue  
Sheridan, WY 82801

Soil Analysis Report  
Environmental Industrial Services

Page 4 of 4

Client Project ID: Andalex Res/Gas

31 North Main Street  
Helper, UT 84526

Set #0105S09795

Date Received: 10/17/05

Report Date: 11/11/05

Lab Id	Sample Id	Depths (Inches)	Sand %	Silt %	Clay %	Texture	Very Fine Sand %	Nitrogen Nitrate ppm	Available Potassium ppm	Available Phosphorus ppm	Organic Matter %	CO <sub>3</sub> Equivalent %
05S09803	9-GVH8	0 - 6	39.0	37.0	24.0	LOAM	21.9	0.02	314	49.5	6.6	1.0
05S09803D	9-GVH8	0 - 6	41.0	35.0	24.0	LOAM	23.4	0.02	317	51.7	6.4	1.1
05S09809	15-GVH9	22 - 36	19.0	29.0	52.0	CLAY	13.5	<0.02	140	1.96	0.7	0.9
05S09809D	15-GVH9	22 - 36	21.0	27.0	52.0	CLAY	15.2	<0.02	136	1.79	0.8	0.9

These results only apply to the samples tested.

Abbreviations for extractants: PE= Saturated Paste Extract, H<sub>2</sub>SO<sub>4</sub>= water soluble, AB-DTPA= Ammonium Bicarbonate-DTPA, AAO= Acid Ammonium Oxalate  
Abbreviations used in acid base accounting: T.S.= Total Sulfur, AB= Acid Base, ABP= Acid Base Potential, PyrS= Pyritic Sulfur, Pyr+Org= Pyritic Sulfur + Organic Sulfur, Neut. Pot.= Neutralization Potential  
Miscellaneous Abbreviations: SAR= Sodium Adsorption Ratio, CEC= Cation Exchange Capacity, ESP= Exchangeable Sodium Percentage

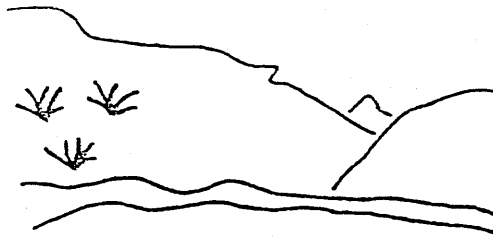
Reviewed By: Jay Shulley  
Inter-Mountain Laboratories, Inc.

UTAH OIL GAS AND MINING

GUIDELINES FOR MANAGEMENT OF TOPSOIL & OVERBURDEN

# GUIDELINES FOR MANAGEMENT of TOPSOIL and OVERBURDEN

R645-301-200 SOILS



Utah Oil Gas and Mining

STATE OF UTAH  
DEPARTMENT OF NATURAL RESOURCES  
DIVISION OF OIL, GAS AND MINING  
1594 W. North Temple, Suite 1210  
P.O. Box 14501  
Salt Lake City, Utah 84114-5801  
(801) 538-5340

DRAFT  
June 2003

Table 2. Field Parameters For Baseline Soil Characterization

Test to be Performed	Reported As	Suggested Methods
Texture	% sand, silt, clay	U.S. Department of Agriculture, Natural Resource Conservation Service, 1998. Field Book for Describing and Sampling Soils, Version 1.1. p 2-28 -2-31.
Structure/Consistence	grade, size, type	Ibid. p 2-38 through 2-51.
Visual Estimate % Coal	% area & size fragments	Ibid. p 2-20, 2-26, 7-1, 2-29, and 2-37.
Internal Rock	% volume & size fragments	Ibid. p2-32 through 2-37 and p2-20 and p 2-26.
Surface Rock	% cover & size fragments	Ibid. loc cit.
Soil Color	Hue Value/Chroma	Ibid. p 2-7 through 2-15.
Bulk Density	g/cm <sup>3</sup>	Soil Science Society of America. 1986. Series No. 5. Methods of Soil Analysis: Part 1 - Physical and Mineralogical Methods. Chapter 13. p 367. Excavation Method.
Chemical Response	pH	U.S. Department of Agriculture, Natural Resource Conservation Service, 1998. Field Book for Describing and Sampling Soils, Version 1.1. p 2-64.
	EC	Ibid. p 2-66.
	Effervescence	Ibid. p 2-65.
	Gypsum	U.S. Salinity Laboratory Staff. 1954. Diagnosis and improvement of saline and alkali soils. USDA Handbook 60. Method 22a. p102.

Table 3. Analytical Methods For Baseline Soil Characterization

Test to be Performed	Reported As	Suggested Methods <sup>1</sup>
pH	saturated paste standard units	Soil Science Society of America. 1996. Series No. 5. Methods of Soil Analysis: Part 3 - Chemical Methods. Chapter 14, page 420 and Chapter 16, page 487.
Saturation %	%	USDA-NRCS. 1996. Soil Survey Laboratory Methods Manual. (SSIR No 42) v. 3.0, Method 8A, page 402.
EC <sub>e</sub>	dS/m @ 25°C (or mmhos/cm)	Ibid. Chapter 14, pp 420 - 422 and pp 427 - 431.
Soluble Na, K, Mg, Ca	meq/L	Ibid. Chapters 14 pp 420-422 (saturation extract); Chapter 19 pp 555-557; Chapter 20 pp 586-590 (spectroscopic methods).
Available NO <sub>3</sub> -N	mg/Kg	Soil Science Society of America. 1996. Series No. 5. Methods of Soil Analysis: Part 3 - Chemical Methods. Chapter 38. p 1129 (KCl extraction). For analysis follow: Sims, J.R. and G.D. Jackson. 1971. Rapid Analysis of Soil Nitrate with Chromotropic Acid. Soil Sci. Soc. Am. Proc. 35-603-606.
Available Phosphorus	mg/Kg	Soil Science Society of America. 1996. Series No. 5. Methods of Soil Analysis: Part 3 - Chemical Methods. Chapter 32, page 895. (NaHCO <sub>3</sub> Extraction.)
Particle Size Analysis	% very fine sand, sand, silt, clay	Soil Science Society of America. 1986. Series No. 5. Methods of Soil Analysis: Part 1 - Physical and Mineralogical Methods. Chapter 15 pp 398 and 404-409 (Hydrometer Method).
Organic Matter	%	Western States Laboratory Proficiency Testing Program Soil and Plant Analytical Methods. 1998. v 4.10. p 86. (Loss on Ignition, convert %LOI to OM by regression intercept value as noted in method)
CaCO <sub>3</sub> %	%	Ibid. p. 99 (Soil Carbonates, Gravimetric Determination after extraction with 3 HCl.) Total Inorganic Carbon = %CaCO <sub>3</sub> x 0.12.
Extractable Potassium	meq/100 g <sup>-1</sup>	Western States Laboratory Proficiency Testing Program Soil and Plant Analytical Methods. 1998. v 4.10. p 73

<sup>1</sup> Laboratories vary in their capabilities. Specify these recommended methods to the laboratory. Use of other methods should be discussed with the Division.



Table 4. Soil and Spoil Suitability/Unsuitability Evaluation

CRITERIA	GOOD	FAIR	POOR	UNACCEPTABLE
Saturation %	25 to 55	≥56 - 80	<25 >80	
pH	6.5 to 8.2	6.0 to 6.4 8.2 to 8.5	5.5 to 6.0 8.6 to 9.0	< 5.5 > 9.0
EC (mS/cm 25°C)	0 to 4	4 to 8	8 to 15	> 15
SAR <sup>a,b</sup>	0 to 4	5 to 10	10 to 14	> 14
%CaCO <sub>3</sub>	<15	15 - 30	>30	
Texture <sup>c</sup>	sl, l, sil, scl, vsl, fsl	cl, sicl, sc, ls, lfs	sic, s, sc, c, cos, fs, vfs	g, vcoss
Total Organic Carbon	<10%			10%
Available Water Capacity <sup>d</sup>	> 0.10 moderate	0.05 to 0.10 low	<0.05 very low	
K factor <sup>e</sup>	<0.37	0.37	> 0.37	

<sup>a</sup> For clay textured soils unacceptable is SAR >14. For sandy textured soils unacceptable is >20.

<sup>b</sup> For most Western soils, the SAR to ESP relationship is usually 1:1, up to ESP ≈ 20. If SAR>20, then determine ESP. (Evangelou, 2000.)

<sup>c</sup> s=sand, l= loam, si= silt, c= clay, v= very, f= fine, co=coarse, g=gravel

<sup>d</sup> Available Water Capacity is adjusted for texture and SAR.

<sup>e</sup> K factor recommendations from the USDA Soil Conservation Service. 1978. National Soils Handbook Notice 24. (3/31/78). NSH Part II -403.6(a). For Prime Farmland soils, the K factor times the percent slope should be a value of five or less for minimal erosion hazard.

SOIL DESCRIPTION  
AND  
DIAGRAMS

Andalex Res., Inc.

## SOIL DESCRIPTION

Soil type *Like Seneschon*  
*more vfs than normal*File No. *GVH5A*

Area	<i>Aberdeen Mine</i>		Carbon Co., Utah	Date	<i>10/6/05</i>	By	<i>Don Larsen</i>	Stop No.	<i>p1</i>
Classification	<i>fine-loamy, mixed, superactive Pachic Argicrysol</i>								
Location	<i>Near center stake at GVH5A</i>				<i>S31, T12S, R1E</i>				
N. veg. (or crop)	<i>Sagebrush</i>				Climate <i>Cryic</i>				
Parent material	<i>Sandstone and shale</i>								
Physiography	<i>Gently sloping upper mountain slope</i>								
Relief	<i>Gentle</i>				Drainage			<i>Well drained</i>	
Elevation	<i>8480 ft.</i>				Gr. water			Salt or alkali —	
Slope	<i>3-5%</i>				Moisture			Stoniness —	
Aspect	<i>NW</i>				Root distrib.			% Clay *	
Erosion	<i>Slight</i>				% Coarse fragments *			% Coarser than V.F.S. *	
Permeability	<i>Moderate to slow</i>								
Additional notes									

## Samples Taken:

*GVH5A 0-9"**9-19"**26-36"**- GVH5A 24-33" from**pit 304, similar**to 9-19" layer in pit #1*

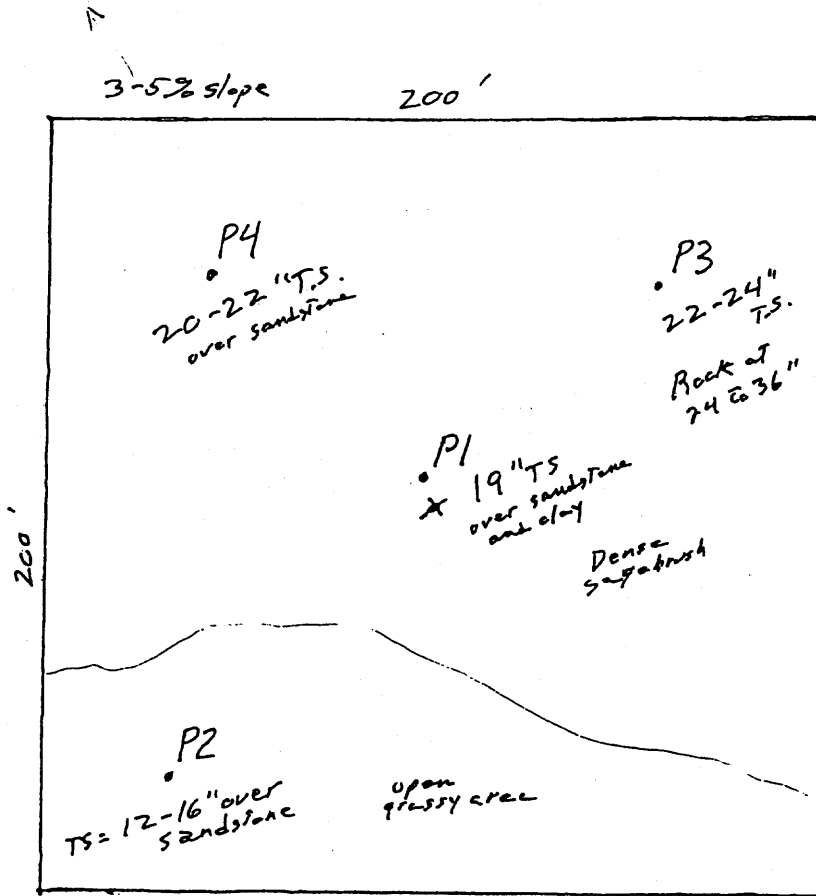
\* Control section average

Horizon	Depth inches	Color		(Lab) Texture Field est.	Structure	Consistence			10% H <sub>2</sub> O Reaction Lab. pH	Bound- ary	% Rock Frag- ments	Root Dist- ribution		
		Dry	Moist			Dry	Moist	Wet						
A1	0-5		10YR 3/2 - 7.5YR 3/2	SIL	MFGA	SO	FA	S/p	eo	9W	25% 91	MDF- M		
A2	5-9		"	(L)* SIL	MFGA + MFSBK	SH	FR- FI	S/p	eo 6.5	9W	"	"		
BT1	9-19		7.5YR 3/2 - 10YR 3/2	(CL)* SIL	MFGA MFSBK	SH	PI	S/p	eo 6.6	CW	58% 200	CF- M		
BT2	19-26	High rock fragment layer mixed color		SIL	"	SH	F	S/p	eo 7.0	CW	20% 300 550	FCW		
BT3	26-36		5YR 5/4	(SIC) SIC	SF-M SBK	H	VFI	VS/ VP	eo	CW	10% 100			
R	36-48	Sandstone bedrock									2% 90- 100%			

(L) is 67.7% Si + vfs

(CL) is 28% clay, harder than

GVH5A



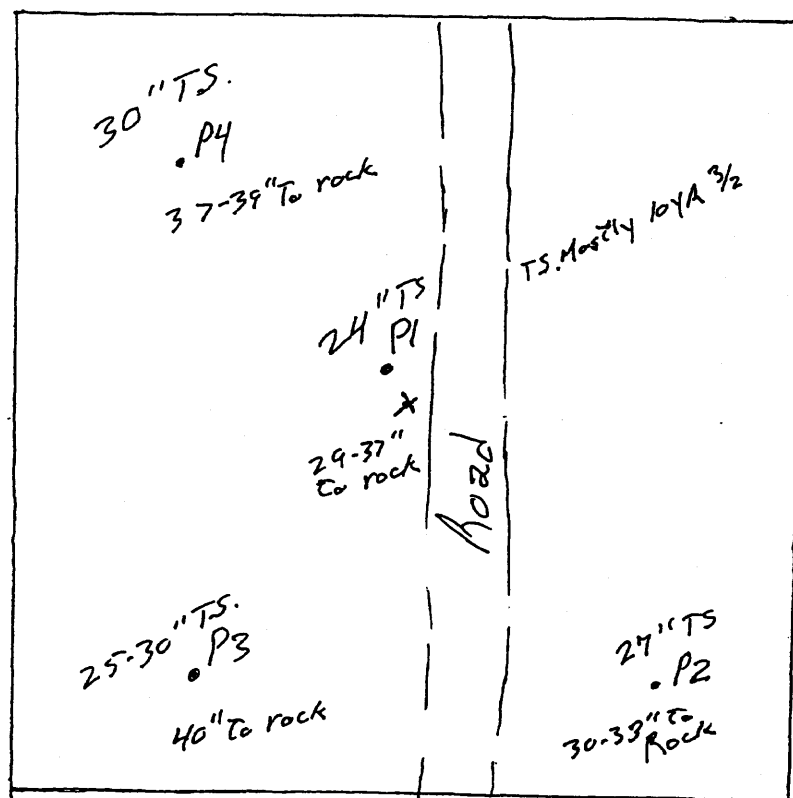
"Topsoil": 14-24"

Aspen/snowberry



GVH7

Slope: 7% NW



Dense  
sagebrush  
over the area

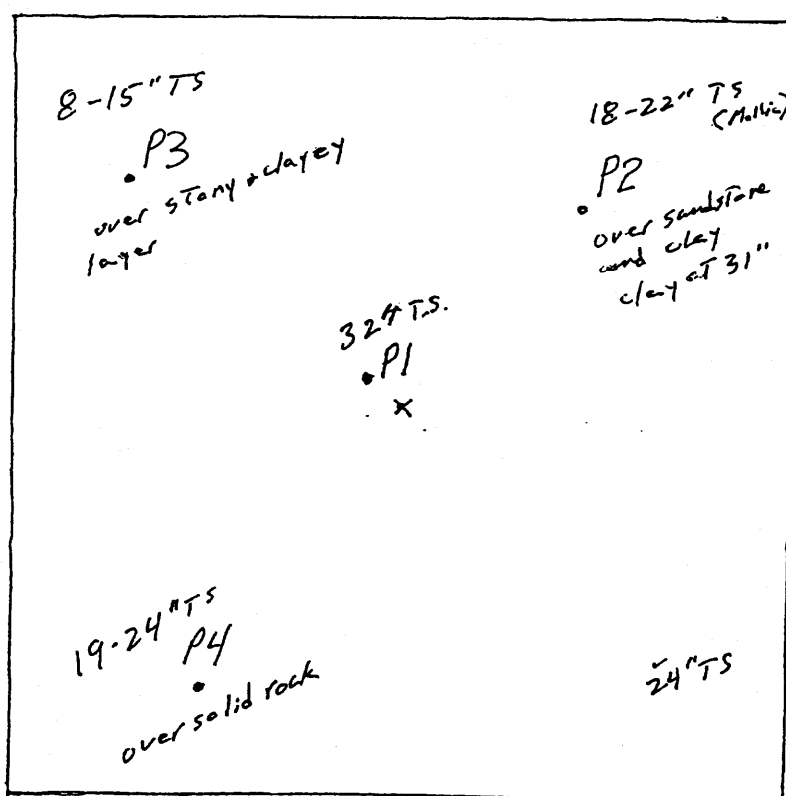




GVH 8

Slope: about 10% NW  
Veg: Aspen-snowberry

4  
N



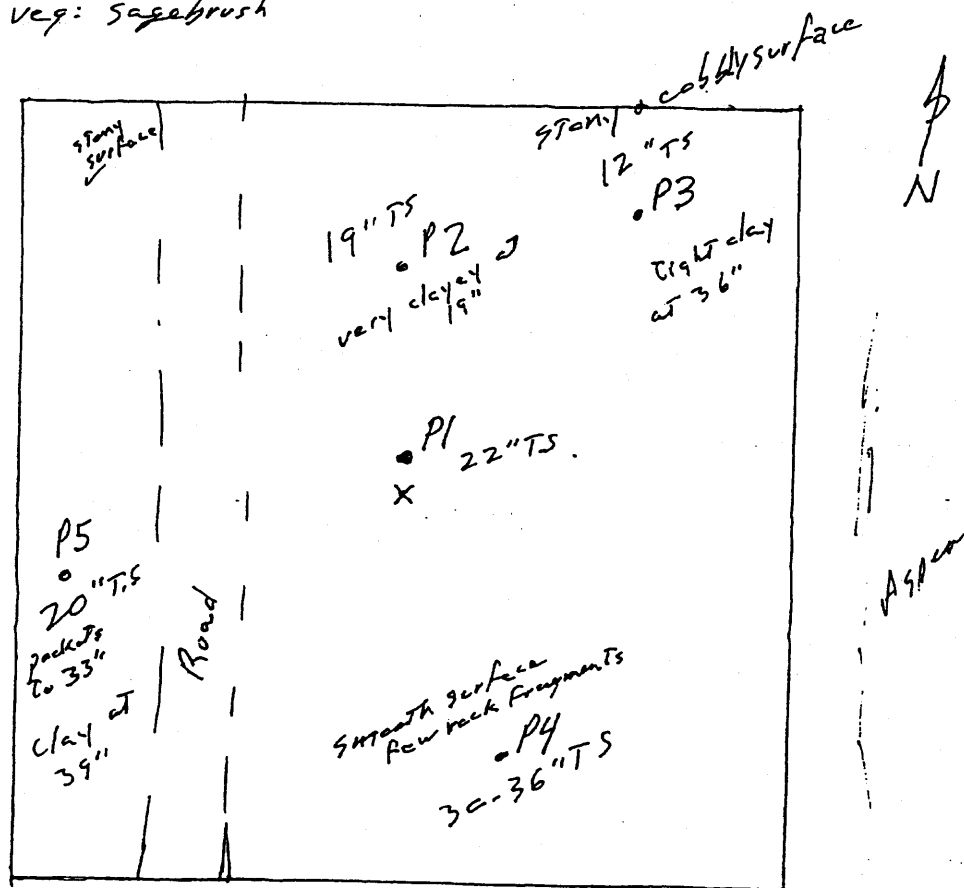
Ave: about 20" of  
"Topsoil"

Range: 8 to 32"



GVH9

Slope: NW (general) about 10%  
veg: Sagebrush

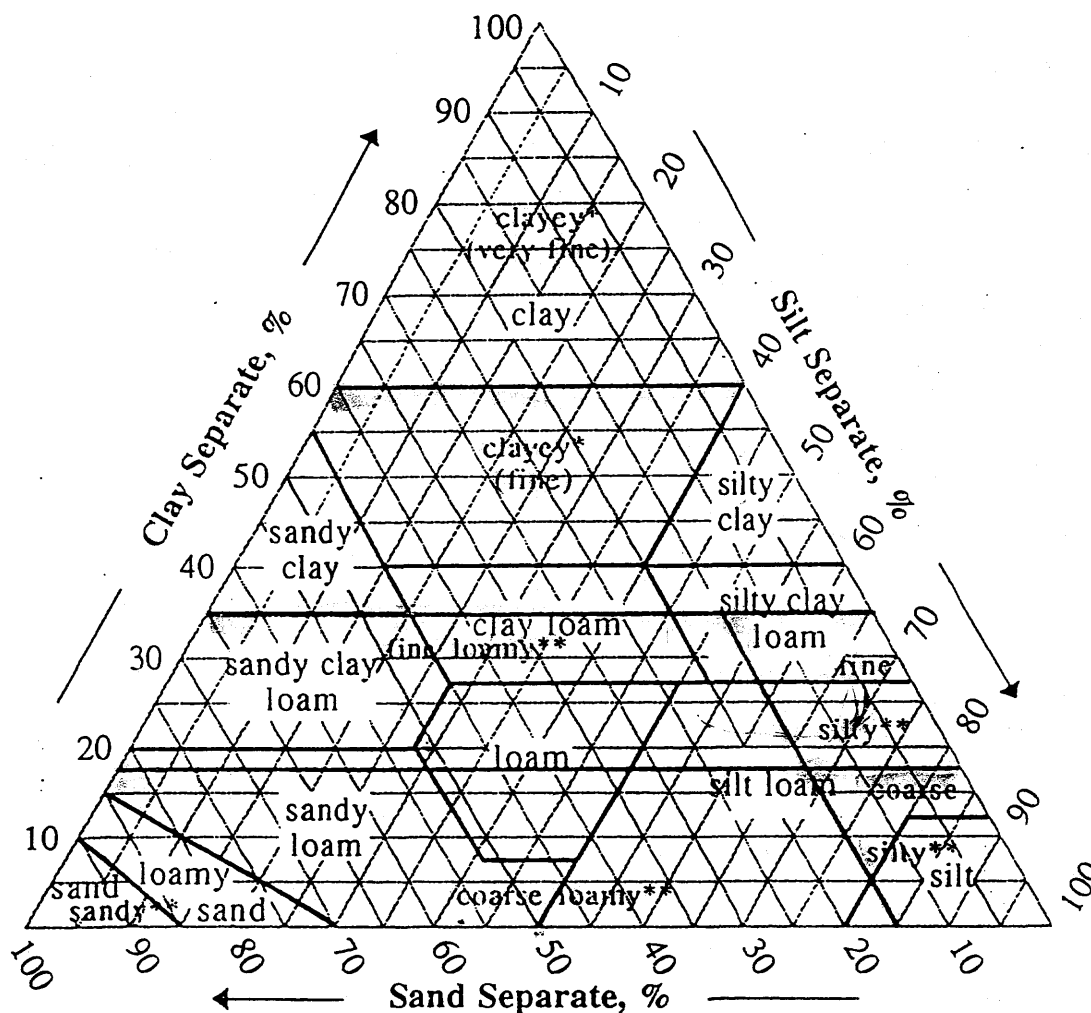


S  N

Surface shape S to N  
North side is on a slight rise  
and has rock at the surface.  
Deeper soils on south 1/2

# APPENDIX IV

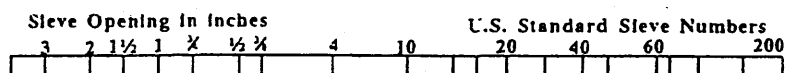
## GUIDE FOR TEXTURAL CLASSIFICATION IN SOIL FAMILIES



\* Clay-size carbonate is treated as silt.

\*\* Very fine sand (0.05 - 0.1 is treated as silt for family groupings; coarse fragments are considered the equivalent of coarse sand in the boundary between the silty and loamy classes.

### COMPARISON OF PARTICLE SIZE SCALES



PHOTOS



**ATTACHMENT 2-1**  
**SOIL INVENTORY AND ASSESSMENT**  
**APPROVED HOLES GVH-1 through GVH-9**

**ATTACHMENT 2-1**  
**SOIL INVENTORY AND ASSESSMENT**

U.S. DEPARTMENT OF AGRICULTURE  
SOIL CONSERVATION SERVICE

R. 10 E. | R. 11 E. (Joins sheet 4)

T. 13 S. | T. 12 S.  
510 000 FEET

2 220 000 FEET



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JUN 29 2005

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son Area, Utah

The potential plant community on the Senchert family soil is 60 percent grasses, 25 percent forbs, and 15 percent shrubs. Among the important plants are Thurber fescue, mountain brome, slender wheatgrass, aspen, sagebrush, and mountain big sagebrush.

Management practices that maintain or improve the rangeland vegetation include proper grazing use, a planned grazing system, and proper location of water developments. If the desirable forage plants are mostly depleted, brush management and seeding can be used to improve the rangeland vegetation. Suitable brush management practices include prescribed burning, chemical spraying, and mechanical treatment.

The suitability of the Senchert family soil for rangeland seeding is good. Plants suitable for seeding include adapted native plants and smooth brome, regar brome, alfalfa, and bitterbrush.

This map unit is in capability subclass VIe, nonirrigated. The Senchert soil is in the High Mountain Loam (Engelmann Spruce) woodland site. The Senchert family soil is in the High Mountain Loam (Thurber Fescue) range site.

**103—Senchert-Toze family complex.** This map unit is on north, east, and west aspects of mountain slopes. It is in the vicinity of the Patmos Head, Mount Bartles, and Camp Creek. Slopes are 15 to 35 percent. The vegetation is mainly aspen, white fir, and Douglas-fir. Elevation is 7,500 to 9,500 feet. The average annual precipitation is about 20 to 25 inches, the average annual air temperature is 36 to 38 degrees F, and the average freeze-free period is 40 to 60 days.

This unit is 50 percent Senchert loam, clayey substratum, 15 to 30 percent slopes; 30 percent Toze family loam, 15 to 35 percent slopes; and 20 percent other soils. The Senchert soil is in plane areas, and the Toze family soil is in concave areas. The components of this unit are so intricately intermingled that it was not practical to map them separately at the scale used.

Included in this unit are about 5 percent soils that are similar to the Senchert soil but are 40 to 60 inches thick; 5 percent Podo gravelly sandy loam, dry, 8 to 30 percent slopes, on canyon rims; 5 percent Trag clay loam in small sagebrush parks; and 5 percent soils that are similar to the Toze family soil but have slopes of 35 to 50 percent.

The Senchert soil is moderately deep and well drained. It formed in residuum and colluvium derived dominantly from sandstone and shale. Slopes are 300 to 400 feet long and are concave. Typically, the surface is covered with a mat of partially decomposed leaves, twigs, and needles about 1 inch thick. The surface layer is very dark grayish brown loam 4 inches thick. The subsoil is grayish brown clay loam about 14 inches thick. The substratum to a depth of 25 inches is light brownish gray clay over calcareous sandstone. Depth to sandstone ranges from 20 to 40 inches.

Permeability of the Senchert soil is moderately slow. Available water capacity is about 3.5 to 5.0 inches. Water supplying capacity is 8.5 to 12.0 inches. Effective rooting depth is 20 to 40 inches. The organic matter content of the surface layer is 5 to 10 percent. Runoff is slow, and the hazard of water erosion is moderate.

The Toze family soil is very deep and well drained. It formed in colluvium derived dominantly from sandstone, siltstone, and shale. Slopes are 200 to 400 feet long and are concave. Typically, the surface is covered with a mat of leaves, twigs, and needles about 1 inch thick. The upper 3 inches of the surface layer is dark grayish brown loam, and the lower 22 inches is dark grayish brown loam and gravelly silt loam. The next layer is grayish brown gravelly silt loam about 8 inches thick. Below this to a depth of 60 inches or more is pale brown very gravelly fine sandy loam. A layer of calcium carbonate accumulation is at a depth of about 24 inches.

Permeability of the Toze family soil is moderate. Available water capacity is about 6 to 9 inches. Water supplying capacity is 11 to 18 inches. The organic matter content of the surface layer is 3 to 5 percent. Effective rooting depth is 60 inches or more. Runoff is medium, and the hazard of water erosion is moderate.

This unit is used as rangeland, woodland, wildlife habitat, and recreation areas.

The potential vegetation on the Senchert and Toze family soils includes an overstory of Douglas-fir with a canopy of 60 percent. The understory vegetation is 10 percent grasses, 5 percent forbs, and 85 percent shrubs. Among the important plants are sedges, mountainlover, snowberry, Oregon-grape, and quaking aspen.

The site index for aspen is 50. Average yield is about 27,200 board feet per acre of trees 12 inches in diameter or more. The unit is moderately limited for producing and harvesting wood products because of the steepness of slope, the hazard of erosion, and plant competition during the regeneration of Douglas-fir.

Management practices that maintain or improve the rangeland vegetation on this unit include proper grazing use, a planned grazing system, and proper location of water developments. The suitability for grazing is poor because of the low forage production. If the Douglas-fir is thinned, the desirable plants present can be expected to increase for a short period before Douglas-fir revegetates the unit.

This map unit is in capability subclass VIIe, nonirrigated, and in the High Mountain Loam (Douglas-fir) range site.

**104—Senchert family, 3 to 15 percent slopes.** This moderately deep, well drained soil is on rolling ridges and plateaus. It is near Steer Ridge, Bruin Point, and Patmos Head. It is formed in residuum and alluvium derived dominantly from sandstone and shale. Slopes are 3 to 15 percent, 200 to 300 feet long, and slightly concave to convex. The present vegetation is mainly

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mountain big sagebrush and Thurber fescue. Elevation is 8,800 to 9,700 feet. The average annual precipitation is about 20 to 30 inches, the average annual air temperature is 36 to 38 degrees F, and the average freeze-free period is 40 to 60 days.

Typically, the surface layer is dark grayish brown loam about 11 inches thick. The subsoil to a depth of 35 inches is dark grayish brown loam and clay loam over sandstone. Depth to sandstone ranges from 20 to 40 inches.

Included in this unit are about 5 percent Beje fine sandy loam intermingled throughout the unit, 5 percent soils that are similar to this Senchert family soil but are more than 40 inches deep to bedrock and are intermingled throughout the unit, 5 percent Senchert loam, 3 to 15 percent slopes, and 5 percent Toze family loam.

Permeability of this Senchert family soil is moderately slow. Available water capacity is about 5 to 7 inches. Water supplying capacity is 12 to 16 inches. Effective rooting depth is 20 to 40 inches. The organic matter content of the surface layer is 5 to 10 percent. Runoff is slow, and the hazard of water erosion is moderate.

This unit is used as rangeland and wildlife habitat.

The potential plant community on the Senchert family soil is 60 percent grasses, 25 percent forbs, and 15 percent shrubs. Among the important plants are Thurber fescue, mountain brome, slender wheatgrass, aspen peavine, and mountain big sagebrush.

Management practices that maintain or improve the rangeland vegetation include proper grazing use, a planned grazing system, and proper location of water developments. If the desirable forage plants are mostly depleted, brush management and seeding can be used to improve the rangeland vegetation. Suitable brush management practices include prescribed burning, chemical spraying, and mechanical treatment.

The suitability of this unit for rangeland seeding is good. Plants suitable for seeding include adapted native plants and smooth brome, regar brome, alfalfa, and bitterbrush.

This map unit is in capability subclass VIe, nonirrigated, and in the High Mountain Loam (Thurber Fescue) range site.

**105 Senchert family-Senchert complex.** This map unit is on mountain slopes. It is east of Scofield Reservoir. Slopes are 30 to 40 percent, 100 to 200 feet long, and concave to convex. Elevation is 8,000 to 9,100 feet. The average annual precipitation is about 20 to 30 inches, the average annual air temperature is 36 to 38 degrees F, and the average freeze-free period is 40 to 60 days.

This unit is 40 percent Senchert family very fine sandy loam, 30 to 50 percent slopes; 35 percent Senchert loam, 30 to 50 percent slopes; and 25 percent other soils. The components of this unit are so intricately

intermingled that it was not practical to map them separately at the scale used.

Included in this unit are about 15 percent Podo cobbly loam and 10 percent soils that are similar to the Senchert soil but have 35 percent rock fragments and are under oak.

The Senchert family soil is moderately deep and well drained. It formed in alluvium and residuum derived dominantly from calcareous sandstone. The present vegetation is mainly mountain big sagebrush, vetch, and Columbia needlegrass. Typically, the surface layer is brown very fine sandy loam about 8 inches thick. The subsoil is brown clay loam about 16 inches thick. The substratum to a depth of 27 inches is very pale brown clay loam over calcareous sandstone. Depth to sandstone ranges from 20 to 40 inches.

Permeability of the Senchert family soil is moderate. Available water capacity is about 4.0 to 5.5 inches. Water supplying capacity is 9 to 13 inches. Effective rooting depth is 20 to 40 inches. The organic matter content of the surface layer is 5 to 10 percent. Runoff is medium, and the hazard of water erosion is moderate. The hazard of soil blowing is moderate.

The Senchert soil is moderately deep and well drained. It formed in colluvium and residuum derived dominantly from sandstone. The present vegetation is mainly aspen, snowberry, and western coneflower. Typically, the surface layer is very dark grayish brown loam about 4 inches thick. The upper part of the subsoil is brown loam about 12 inches thick, and the lower part to a depth of 35 inches is brown clay loam over sandstone. Depth to sandstone ranges from 20 to 40 inches.

Permeability of the Senchert soil is moderate. Available water capacity is about 5 to 6 inches. Water supplying capacity is 12 to 17 inches. Effective rooting depth is 20 to 40 inches. The organic matter content of the surface layer is 5 to 10 percent. Runoff is medium, and the hazard of water erosion is moderate.

This unit is used as rangeland, woodland, wildlife habitat, recreation areas, and watershed.

The potential vegetation on the Senchert family soil is 60 percent grasses, 25 percent forbs, and 15 percent shrubs. Among the important plants are Thurber fescue, mountain brome, slender wheatgrass, mountain big sagebrush, and aspen peavine.

Management practices that maintain or improve the rangeland vegetation include proper grazing use, a planned grazing system, and proper location of water developments. If the desirable forage plants are mostly depleted, brush management and seeding can be used to improve the rangeland vegetation. Suitable brush management practices include prescribed burning, chemical spraying, and mechanical treatment.

The suitability of this soil for rangeland seeding is good. Plants suitable for seeding include adapted native

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SC2-SOILS-2328  
REV: 12-70  
FILM CODE SOILS-11

## SOIL DESCRIPTION

File No.

Soil type

Date 06/21/05

**Stop No.**

Classification Synchrotron Complex

Location 5UH 3, Centennial

## Climate

N, veg. (or crop)

### Parent material

Physiography. Mountainous

Salt or alkali?

Relief. Flat Lying

## Drainage

Stoniness 0-5%

Elevation 8505'

Gr. water None

Slope 0-5%

Moisture 5-10%

**Aspect**

% Clay = 30%

Erosion None Observed

% Coarse fragments = 5%

\* Coarser than V.F.S. \*

### Permeability

Additional notes Very few rock fragments, mostly root-down

As depth increases, angular ss rock fragments

become more frequent, roots become less frequent

Roots are fine to course

\* Control section average

[illegible]

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### SOIL DESCRIPTION

Soil type

Date

**File No.**

**Stop No.**

### Classification

**Location**

N. veg. (or crop)

**Parent material**

### Physiography.

## Relief

**Elevation**

**Slope**

**Aspect**

### Erosion

### Permeability

**Additional notes**

notes

sampled C horizon  
sampled topsoil

## Climate

Salt or alkali	
----------------	--

**Stoniness**

Gravel	Sand	Silt	Clay	% Clay *
100	0	0	0	0
90	10	0	0	0
80	20	0	0	0
70	30	0	0	0
60	40	0	0	0
50	50	0	0	0
40	60	0	0	0
30	70	0	0	0
20	80	0	0	0
10	90	0	0	0
0	100	0	0	0
0	90	10	0	10
0	80	20	0	20
0	70	30	0	30
0	60	40	0	40
0	50	50	0	50
0	40	60	0	60
0	30	70	0	70
0	20	80	0	80
0	10	90	0	90
0	0	100	0	100
0	0	90	10	10
0	0	80	20	20
0	0	70	30	30
0	0	60	40	40
0	0	50	50	50
0	0	40	60	60
0	0	30	70	70
0	0	20	80	80
0	0	10	90	90
0	0	0	100	100

	% Coarser than V.F.S.*
--	------------------------

% Coarse fragments *	100
----------------------	-----

\* Control section average

* Control section average											
Horizon	Depth	Color		Texture	Structure	Consistence			Reaction	Boundary	
		Dry	Moist			Dry	Moist	Wet			
O	0-3"	10YR 5/3	10YR 3/4			VH			None		many fine roots, also coarse
A <sub>1</sub>	3-36	10YR 5/3	10YR 3/4				M		None		some fine roots some coarse
C	36+	10YR 4/6			C				Med		25% rock fragments

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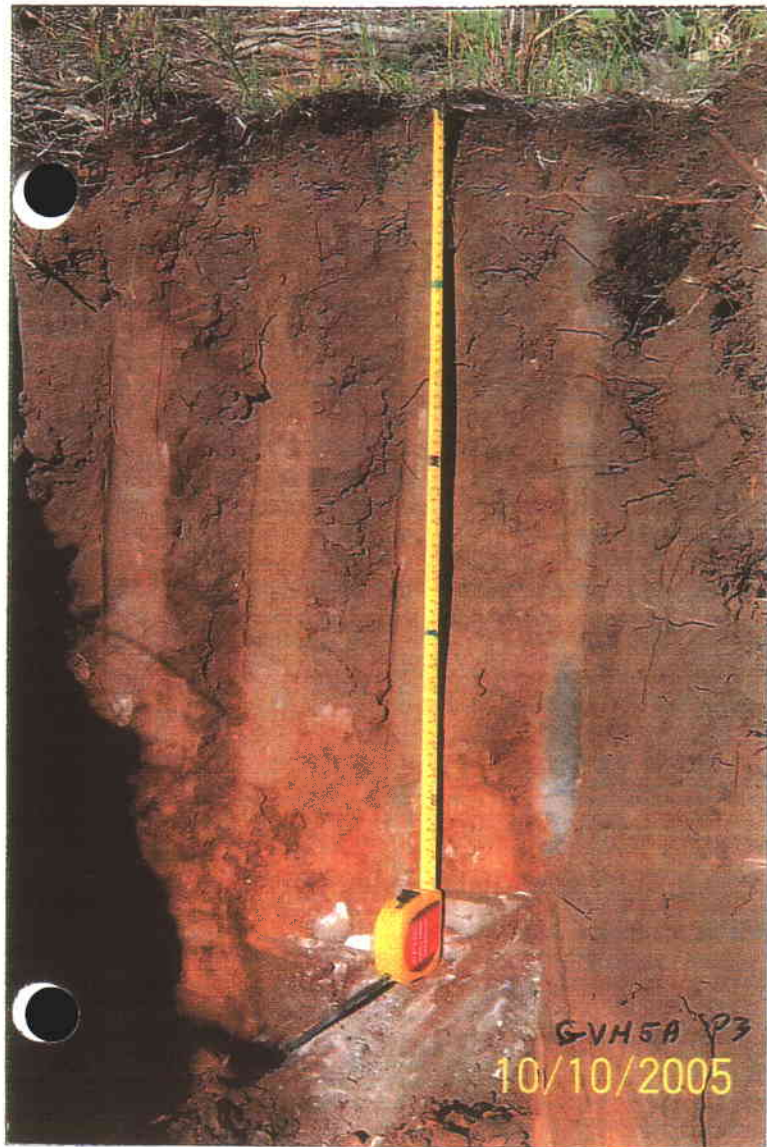
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GVH 5A



GVH 5A

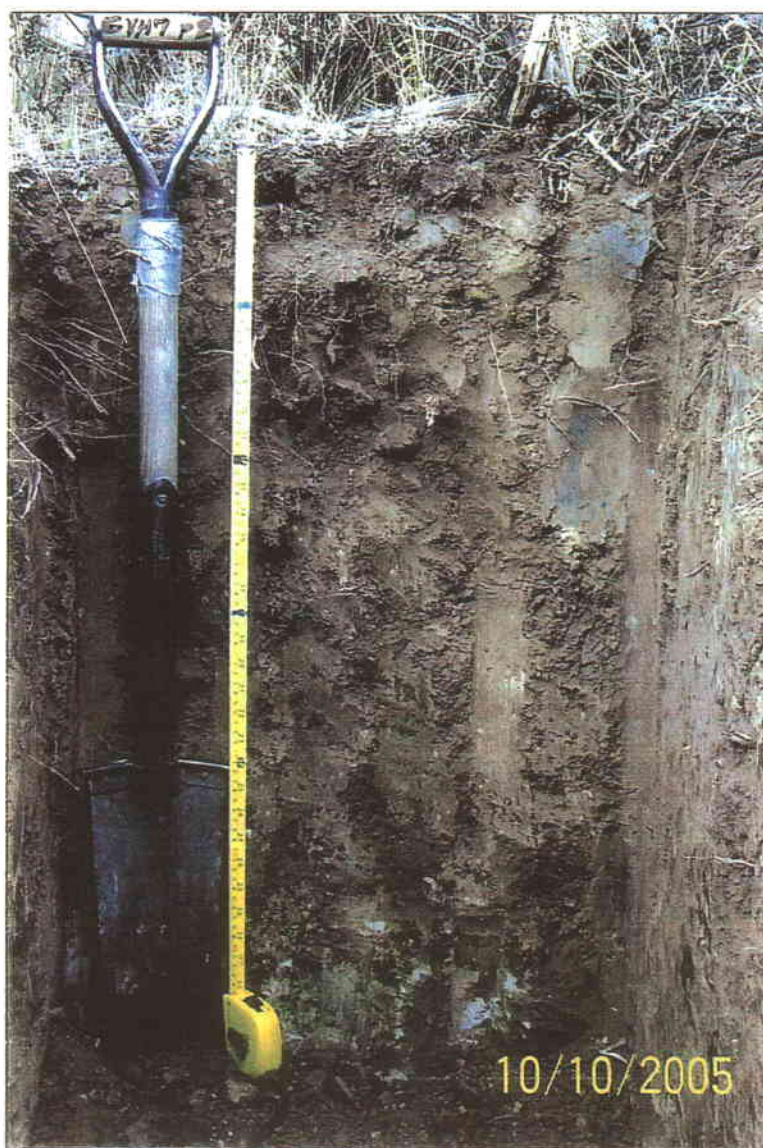






GVH 7





GVH7





GVH8



GVH8 p2



10/10/2005

GVH8



GVH8 p3

10/10/2005



GVH9 P1



GVH 9

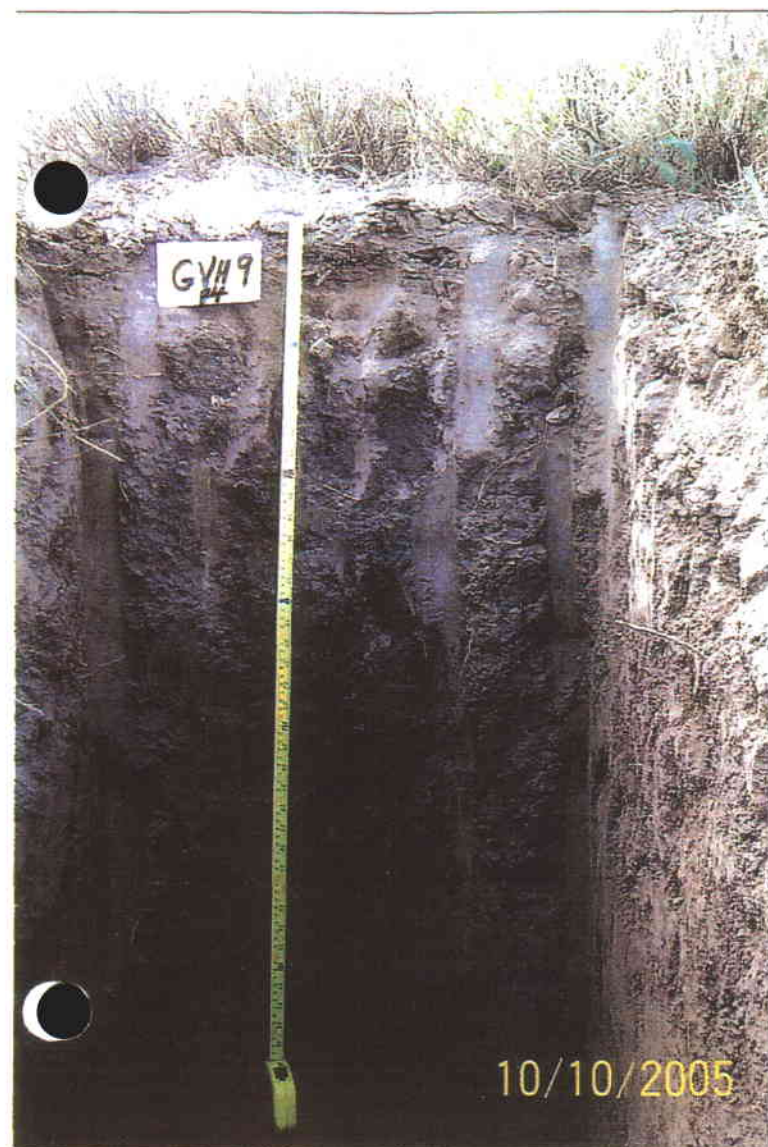


GVH 9



GVH 9





GVH 9



**ATTACHMENT 2-2**  
**SOIL INVENTORY AND ASSESSMENT**

**PROPOSED HOLES GVH-10 through GVH-17**

SOILS REPORT ON GAS VENT HOLE 10

FOR THE  
CENTENNIAL MINE

Prepared by

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For

ANDALEX RESOURCES  
Centennial Mine  
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July 12, 2006

## Introduction

An Order 1 soil survey was conducted at a proposed gas vent borehole drill site above Centennial Mine in Carbon County, Utah. The purpose of this document is to provide a detailed description of the soil resources including their quality and quantity that occur on a one acre study site (GVH10) prior to its disturbance. This information can then be used to provide a soil reclamation plan, to be followed by engineers in efforts to reclaim the soil to resemble natural conditions prior to disturbance.

## Objectives

A detailed, Order 1 soil map will be provided to determine variations in soil conditions in the one-acre proposed drill site (GVH-10) in accordance with USDA standards (Soil Survey Staff, 1993).

Physical and chemical properties of soils are then tested to determine suitability of soil for reclamation purposes according to R645-301-200 Soil Guidelines for Management of Topsoil and Overburden (OGM Price Field Office, 2005).

A soil topsoil salvage depth estimate will be provided based on this survey and laboratory characterization, with recommendations as to depth of topsoil suitability to be used in reclaiming the site.

## Location and Setting

Figure 1 shows location of the study site on Minnie Maud 7.5 minute Quadrangle. It is located in the NW1/4 of the NW1/4 of Section 29 Township 12 South Range 11 East at approximately 8300 feet. This is approximately 2 miles south of the Emma Park area, within the upper reaches of Summit Creek drainage. The landform is dominantly rolling backslopes of the Bookcliffs escarpment with aspen overstory and snowberry with mixed forb understory. Colluvium and residuum comprised of sedimentary rocks (limestone, sandstone, and shales) of the middle Flagstaff Fm, aged Paleocene to Early Eocene era, are the parent materials. Slopes in the study area range between 0 and 8 percent, with inclusions of steeper (8-15%) on the acre's south and east extent. The aspect in this area is predominantly north. One wet seep areas was noted in the area, bordering the study plot, leading by pipe to a livestock watering trough found below and to the north of the area. Soils found in this approximately 75 sq. ft area were not hydric, nor did they exhibit soil redoximorphic field features.

## Methods

An Order 1 soil map was accomplished using techniques described in Soil Survey Manual (Soil Survey Staff, 1993) and National Soils Handbook (USDA, 2005). Soil

boundaries were determined upon the landscape following a walking reconnaissance of the perimeter of the study area. In this reconnaissance, sharpshooter and auger excavations were made to determine soil epipedon variability, and factors of slope degree and slope positioning were noted. A backhoe was used to sample three sites representing the variability in soil epipedon depths, slopes percentages, and slope position ( Figure 2). The soil profiles were photographed and are included in Appendix 3. Soil profiles were described to a depth of bedrock or 60 inches, whichever came first. The soils were then described by methods and using abbreviations found in Field Book for Describing and Sampling Soils Version 2.0 (Schoeneberger et. al., 2002). Soils were sampled by major horizon boundaries, placed in gallon-sized plastic bags, and sent to BYU Soil and Plant Analysis for characterization of selected chemical and physical properties as indicated in The Analytical Methods For Baseline Soil Characterization (Table 3) in Guidelines for Topsoil Suitability (2003, Price Field Office).

A total of 12 samples, four from each backhoe profile, were sent for lab analysis. In a pre-analysis discussion by phone with Priscilla Burton (June 1, 2006) it was deemed nonessential to test for Boron, Selenium, and acid-base potential due to the high elevation and non-disturbed nature of the study site. In this discussion, it was also decided that selected soil-water relations will not be made by lab methods (bulk density and available water capacity) and can be estimated by using soil textural analyses (SPAW Model, Saxton and Rawls, 2006).

## Previous Studies

Soil Conservation Service has mapped the area of the study site in a general (Order 3) soil survey, and this information is found in the 1988 publication Soil Survey of Carbon Area, Utah (Jensen and Borchert). Map Unit 117 from this report lists the Trag-Bege-Senchert complex in the area encompassing the study site. Map Unit 117 is found on north-facing slopes of plateaus at elevations between 7000 and 8500 feet. The soil Series in this mapping complex are so intricately intermingled upon the landscape that SCS has not separated their boundaries at the scale of 1:24,000 used in this report. Of the three soil Series in the 117 map unit complex, Senchert Series is the only one found under aspen vegetation. This soil is now classified as Fine-loamy, mixed, superactive, Pachic Argicryoll (Official Series Description, NRCS, 1999). See Appendix 1 for this Official Soil Series Description.

Leland Sasser, NRCS Soil scientist at the Price Field Office was contacted by telephone during June, 2006 to ascertain whether my estimation of the field characteristics for Senchert Series in this area would fit his concept for the soil Series, found within this landscape. He said this could be a good fit for his concept of Senchert Soil Series at this place. I have sampled horizons of the three backhoe pits and placed them in micromonolith boxes for correlation reference by interested parties.



## Results and Discussion

Soils of the study area are not considered Prime or Important farmland (Figure 3). The source for this information was gathered from an Internet Publication Titled Carbon County Resource Assessment, a collaboration of USDA and County agencies (August 2005).

Lab results from BYU Soil and Plant Analysis Lab were received on June 23, 2006. Table 1 lists some of the field estimates (textures and coarse fragments) for the soil profiles samples, along with their laboratory analyses (from Guidelines, 2003, Table 3). Soil field estimates for Munsell Color, Surface rock percentages, Structure/Consistence, and pH/effervescence are found in Table 2 of this report, and again on the soil field description forms (USDA- FS 2500) included in Appendix 2.

Values for K-factor and Average Water Holding Capacity in Table 1 of this report are derived mathematically from graphs in National Soils Handbook (2005, amended), and one approach for estimating for soil-water relationships based on soil textures (Saxton, et. al. 1985). Organic Carbon percent was inferred by dividing 1.72 of the percentage of Organic Matter found within the horizons.

Soils in the topsoil of the three pedons described were of a dark brown color, with granular to moderate subangular blocky structure, had good root distribution, with pH's in the 6.5 to 7.7 range. These soils would rate good to fair suitability for use as topsoil in Table 4 of the Guidelines (OGM Price Field Office, 2003). With an exception of one pH in Sample GVH10A (0-6 inches, pH of less than 6.5), and textures of clay loam to clay in the subsoil of the same pedon, all other ratings for topsoil are good.

The upper portions of these soils (called pachic, with greater than 15 inch depth of mollic epipedon properties) fall within the good range for all of the considered chemical and soil physical properties.

In addition to field parameters described and lab analyses, I consulted with the Carbon Area Soil Survey (Jensen and Borchert, 1988) Table 12 on page 280 for estimates of both K factor and available water capacity. The values found for Senchert Series in the Soil Survey of Carbon Area were found to be comparable to those values obtained by using above-mentioned above soil equations and estimates.

## Suitability Assessment and Summary

Table 3 lists soil topsoil suitability depths for the one-acre study site and volume estimates for recoverable materials using the Topsoil Balance Sheet (2005 OGM Guidelines, Table 9). Soils are suitable for topsoil salvage from depths between 15 and 21 inches at the three backhoe sites evaluated. The dark-colored Pachic epipedon (A horizons) with sandy loam, loam, sandy clay loam textures are all recommended for salvage. A soils specialist who can identify these features during time of topsoil removal is advised to be at the site to monitor recovery of materials. Weathered shale bedrock materials occurring in this area at depths between 20 and 38 inches, and one 75 ft. square area of seasonally wet soils are to be avoided in the recovery process.

TABLE 3. Soil Suitability Depths

Sample Site	Average Depth Suitable Soil inches	Area of coverage Feet sq.	Salvageable Soil feet cu.
GVH10A	21 inches	14,520	941
GVH10B	19 inches	14,520	850
GVH10	15 inches	14,520	672

Total Cubic feet of Salvageable soil on one acre study site      2463 cubic feet

## Conclusion

An average depth of 15 to 21 inches of topsoil are found to be suitable for topsoil salvage in the one acre study site GVH-10, based on the data collected at three backhoe excavations on June 2, 2006. The main limitations in the above soil profiles to provide for additional depths of suitable topsoil are clay content in each of the subsoils (Bt horizons, which range between 15 and 50 inch depth in these profiles) and depth to shale or weathered shale and sandstone bedrock (found between 30 and 60 inch depths in the three sample pits). The chemical properties of these soils pose no limitations to with regard to their suitability if salvaged correctly.

## References

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## **APPENDICES**

**APPENDIX 1. Official Soil Series Description for Senchert Series.**

**APPENDIX 2. Pedons descriptions of soils described and sampled in this report**

**APPENDIX 3. Photographs of the sites and backhoe pits described in this report.**

**ATTACHMENT 2-2**  
**SOIL INVENTORY AND ASSESSMENT**

**PROPOSED HOLES GVH-11 through GVH-17**



**REPORT ON SOIL RESOURCES**  
**Of Seven GAS VENT BOREHOLES**

**Sites 11 through 17, Tower Mine, Bookcliffs Area**

December 5, 2006

Prepared for:  
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Prepared by:  
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Escalante, Utah 84726  
435-826-4961

Figure 1 Locations of GVH 11 - 17



0.0 0.5 1.0 miles  
0.0 0.5 1.0 1.5 km

TN MN  
12½°  
12/01/06

## INTRODUCTION

A east to west aligned transect consisting of seven Gas Vent Boreholes (GVH) were surveyed for soil resources for Utah American Energy Tower Mine according to Utah Division of Oil Gas and Mining Guidelines (2005). On September 23 and 24, 2006, a total of 10 backhoe pits representing a range of slope and vegetation variability across a one mile transect of the Bookcliffs were described and sampled for laboratory characterization. The seven sites are referred to in this report as GVH 11 through GVH 17, which represent a portion of a "Panel" of Gas Vent Boreholes above Tower Mine, spaced approximately 1000 feet apart. The soil backhoe locations were chosen to represent the average depths in the soil topsoil at each of the one-acre drill sites. Soil pedon locations were based upon a prior familiarity with this area, and my time spent walking across the extent of the sites with preliminary auger probes.

Objectives for the soil study are to make recommendations for an average topsoil salvage depth at each of the seven GVH sites, to assess the physiochemical suitability of the topsoil, and rate the suitability of any subsoil which can be potentially useful as a substitute growth medium if it is necessary to supplement unsuitable topsoil deficiencies. Finally, any limiting soil or landform factor related to plant growth in these areas will be addressed in the report, with recommendations as how to overcome the problem.

### Study Area Location and Geologic Setting

The study area (Figure 1) is located on the backslope of the Bookcliffs Area of Carbon County, Utah at elevations of between 8100- 8300 feet. They are all located within Section 36, and the northern edge of Section 31, R10 & 11 E, T 12 S on the Minnie Maud 7.5 minute Quadrangle. The area is accessed by a steeply graded dirt road and jeep trails beginning at the locked gate beyond the Tower Mine Portal, and is approximately 3 miles to the north of the Tower Mine Portal area, in the upper tributaries of Buck, Antone, and Summit Creeks.

The geology of the area includes colluvium and residuum comprised of sedimentary rocks of Paleocene to Early Eocene aged Flagstaff and North Horn Formations. The dominant parent materials are sandstone, shale, and limestone. Slopes vary from level to very steep across the headwaters of the Emma Park tributary drainages, including steeply sloping canyonsides with 50% slopes, to 0-5% sloping ridges. A mixture of sagebrush, serviceberry, rabbitbrush, snowberry, forbs, grasses, and aspen forest types represent the vegetation across the mile and one half extent of this panel. The vegetation changes across this landscape appear to be a result of both soil and aspect driven parameters.

### PREVIOUS STUDIES

A soil survey completed in 2005 by Daniel Larsen (EIS Environmental and Engineering Consultants, Price, Utah) was reviewed prior to initiating this fieldwork. Some of the Larsen study sites are adjacent to the present study area, along the GVH panel to the south approximately 1000 feet. According to Mr. Larsen's report, there were few limiting soil factors in the areas where he sampled and described soils for Andalex in 2005. My initial trip to this area was in June of 2006. I sampled and described three backhoe pits at one site, GVH-10, also for Andalex. My soils report (Chesler, July 2006) on GVH-10, located to the east of the present survey area, concluded that an average of between 15 and 21 inches of suitable topsoil could be salvaged from a gently sloping aspen forest area, with the only limitations being a moderately-deep bedrock contact on steeper, convex shaped slopes of the area.

### METHODS

A review of Carbon Area Soil Survey (USDA, 1988) was made prior to my field visit, to familiarize myself with the previous Order 3 soil mapping in this area. From my previous work at the adjacent GVH-10 earlier in the summer of 2006, I am somewhat familiar with the soils and landscapes of this area. Five map units identified on Sheet #10 of the Carbon Area Soil Survey, including several Soil Series, cover the extent of my

study area and are described in the text of the Soil Survey. Table 1 lists Series that I found to resemble soils described in my field investigations, and included soil types which are currently under consideration for these areas (personal comm. With NRCS Soil Scientist, Leland Sasser). I had an expectation of between 1 and 2 feet depths of suitable topsoil in the aspen forests in the area, but had not seen soil of the other vegetation types on my previous visit. I did have the expectation that less topsoil could be salvaged from steeper, convex shaped, and the sparsely vegetated sites.

I met the backhoe operators, Scamp Excavating, early on Sept. 23, and proceeded to visit each site in order to assess backhoe site locations. At each one-acre site, I walked 100 feet in each direction from a survey stake located at each site center to make assessments of slope and aspect variability, surface stoniness, and probed with hand auger to determine topsoil textures and depths. Once satisfied with the site's potential topsoil depth variability, one to two backhoe pit sites were flagged with orange tape and located on GPS to represent soil pedons at the major vegetation and landscape changes.

A total of 11 soil pedons were excavated at the seven Gas Vent Borehole Sites during the next two days. Soils were described to a depth of five feet where possible, or to the depth where either bedrock or any restricting layer was observed. I described soil profiles at the backhoe pits according to the Field Guide For Describing and Sampling Soils Version 2.2 (Schoeneberger, et. al. 2005). An average of three to four depth increment soil samples were placed in gallon sized plastic bags from each soil pedon, and all samples except one (GVH- 15B, very shallow to bedrock) were sent on September 29, 2006 to BYU Soils and Plant Analysis Lab for testing. Soil colors, structure, consistence, reaction to HCl, root distribution, boundaries, pores, and other special pedologic features were noted on soil description forms along with my hand drawn planimetric sketch of the site layout on back. Soil backhoe pits were photographed along with the surrounding landscape of the representative soil profiles.

## RESULTS and DISCUSSION

Following receipt of the laboratory results of 35 soil samples at the seven GVH sites from BYU on November 5, 2006, I made taxonomic classifications to complete my field soil survey notes. Table 1 lists these soil classifications along with NRCS Soil Series and SCS map units, for this area of Carbon County that are mapped by SCS, or under current consideration, for this area of Carbon County. The results from the laboratory physical and chemical analyses are presented an Appendix 1. Soil profile descriptions and classifications for the eleven backhoe sites are provided in Appendix 2. Appendix 3 contains Official Soil Series Descriptions for correlated soils described in this study.

Table 1. SOIL CLASSIFICATION AND CORRELATION TO NRCS CARBON AREA SURVEY

Site ID	Soil Classification	1988 SCS Map Unit	Correlated NRCS Soil Series *
GVH11A	Loamy-skeletal, Pachic Haplocryoll, MD	97	Midfork Family
GVH11B	Loamy-skeletal, Pachic Haplocryoll MD	117	Senchert, stony
GVH12	Loamy-skeletal Lithic Argicryoll	117	Beje, stony
GVH13A	Fine, Calcic Pachic Argicryoll	117	Aagard, clayey
GVH13B	Fine, Calcic Pachic Argicryoll	105	Aagard, clayey
GVH14	Fine, Pachic Argicryoll	105	Millerlake, high clay
GVH15A	Fine, Calcic Pachic Argicryoll	104	Aagard, clayey
GVH15B	Loamy-skeletal Lithic Haplocryoll	104	Beje, very shallow
GVH16A	Fine, Pachic Argicryoll	7	Millerlake, high clay
GVH16B	Fine-loamy Pachic Haplocryoll	7	Rottulee Family
GVH17	Fine, Pachic Argicryoll	7	Millerlake, high clay

\* Several of these Soil Series are currently being considered for use in this area, Leland Sasser, personal communication, Nov. 28, 2006



Following are my individual descriptions of the soil resources at each of the seven sites, accompanied by soil pedon and landscape photographs.

#### GVH11

This is the easternmost in the panel addressed in this report and is located along a convex ridgeline with a jeep trail bisecting the one acre site. Approximately half of the area is covered by sagebrush – serviceberry vegetation, the other in under an aspen canopy. Two soil pedons, one in sagebrush (11A), and one in aspen (11B) were sampled to reflect this sites soil variability. Slopes range from 0-5 % on the brush covered ridgetop to 15-25% on the NE trending aspen-covered sideslopes. Both soils are located on convex to slightly concave positions and are moderately deep to calcareous sandstone bedrock. Topsoil depths range between 8 inches in 11A to 17 inches in 11B. Coarse fragment content averaged between 25-40 % in the soils at these two sites, and poses a slight limitation toward topsoil removal and plant water holding capacity. Bedrock depth ranges between 25 and 34 inches at these sites. Lab tests of both the topsoil and subsoil at these sites rated good for soil texture, pH, EC, SAR, and & CaCo3 percentage in the Guidelines for Topsoil Suitability (DOGM, 2005, Table 4). Midfork Family (11A) and Senchert Series, stony phase (11B) closely resemble the soils I have described here.



Photograph of GVH11A Landscape



GVH11A Soil Profile





Pedon Photograph and Landscape, Site GVH11B

## GVH12

This site is characterized by undulating ridgetops covered with servicberry, mountain big sagebrush, and grasses. Slopes range from 0-15% and surfaces are very stony and bouldery. Northerly aspects are prevalent, and the soils are found on convex to planar surfaces. One backhoe was excavated at this site, when I found upon reconnaissance that all soils are shallow to bedrock. Soils are very stony with up to 40% coarse fragments throughout the profile, and bedrock is between 8 and 12 inches. Beje Series, stony phase closely resemble the pedon I have described and sampled (GVH12) for this report. Only 6 –10 inches of topsoil can be salvaged from this site, and all of the soil physical and chemical parameters tested have the good topsoil suitability ratings.



Photograph of GVH12 Landscape.



Photograph of GVH12 Soil Pedon



### GVH13

This site is located along an upper forks of Summit Creek, and two soils have been characterized in a toeslope aspen grove within a small canyon bottom. To the west of these sites is a meadow bordered canyon that turns into Right Fork of Summit Creek. Slopes range from 20-40% and are facing northwest. The soils have deep, dark-colored topsoil between 20 and 25 inches deep and have few coarse fragments in the upper two feet. Topsoil has good ratings in soil textural, pH, EC, CaCo<sub>3</sub>, SAR parameters. Subsoil between 25- 40 inches (GVH-13B) have clay texture, and CaCo<sub>3</sub> in the fair rating category. Site 13A has similarly fair rated soil for CaCo<sub>3</sub> between 34-60 inches, but otherwise rates good in all other soil parameters tested. Both soil profiles resemble Aagard Series, clayey phase.



Landscape Photo GVH13A



Soil pedon GVH13A



Landscape and soil pedon Site GVH13B



#### GVH14

This site is located within a sagebrush and rabbitbrush covered swale with slopes ranging between 5-15% and a northerly aspect. One soil backhoe pit was described and sampled to a depth of five feet to represent soil types at this site (GVH14). The concave sloping surfaces which have larger sagebrush growing upon them have correspondingly deeper topsoil. The upper 21 inches of this soil is without coarse fragments and have good soil test parameter ratings throughout. Subsoil with depths between 21-60 inches also rate favorably in all soil test physical and chemical tests, so that use of this subsoil may be available to use as substitute topsoil for other areas nearby, such as GVH-12 and GVH-15. Soils here resemble Millerlake Series, high clay phase, and have over four feet of suitable plant growth material in the concave lower sideslope positions.



Landscape Photo of GVH14



GVH14 Soil Profile

#### GVH-15

This site is located along a northerly facing spur ridgeline in the upper reaches of Antone Creek. The ridgecrest is very rocky, with shallow to bedrock soil profiles and were characterized, though not sampled, by site GVH15B. They are related to Beje Series, very shallow to sandstone bedrock. My feeling is that these soils do not have enough volume to sample for topsoil characterization, and once the nearby deeper to bedrock soils are salvaged, adequate substitute materials can be borrowed from these moderate deep to deep soils profiles to offset those located along convex ridgelines. The deeper soils occur to the northwest of the ridge on planar to concave slopes between 15-25%. Site GVH15A has 18 inches of topsoil with its silty clay texture representing the only fair rated soil parameter tested. Subsoil have between 5-20% coarse fragments, a fair rated silty clay texture, and poor CaCo<sub>3</sub> percentage content in the 30-54 inch depth. The site resembles Aagard Series, clayey phase, with higher clay percentages in the control section.



Landscape and soil profile GVH15A

#### GVH-16

This site adjoins a sagebrush /aspen transition along an undulating ridgetop with slopes ranging between 10-20%. Soil located within sagebrush (16B) are shallow to moderately deep to sandstone bedrock and have 14 inches of top-soil without coarse fragments. Their only chemical limitation were pH values, which rated in the fair category, less than 6.5 values. The Rottulee Family Series reflects profile development at this site. Site GVH16A is located in an aspen stand with an open canopy and has up to 24 inches of suitable topsoil and subsoil material with very few coarse fragments. Their only limitation as a plant growth medium are textures of silty clay and lower than 6.0 pH in the fair categories. This is a deep soil to bedrock and has soil morphology similar to Miller Lake Series, clayey phase, with a slightly higher clay content within the control section.





Soil landscape GVH16A



Soil Profile GVH16A



GVH16B Landscape and Soil Profile



## GVH17

This site is the westernmost sample site in the panel, and is located within a small Buck Canyon headwater drainage. One soil pedon was excavated at this site (GVH17), along a gently sloping sagebrush meadow. Slopes up to 20 % occur within this one acre proposed drillsite. The upper 18 inches of the soil profile are suitably rated for topsoil material, while subsoil between 18-50 inches also have good rating for the parameters tested with the exception of clay textures in the argillic horizons. The Miller Lake Series, clayey phase has a similarity to this soil pedon .



Soil Pedon and landscape Site GVH17

Two additional parameters calculated for these soils which are related to their topsoil suitability are Available Water Holding Capacity and K Factor, estimated from models from Saxton, and USDA, respectively. Table 2 includes my coarse fragments estimates from the soil profile descriptions, laboratory soil textures, Organic Carbon %, Saturation %, and calculations of Available Water Capacity and K factors derived from the models mentioned above.

TABLE 2. Soil Physical Properties

sample ID	depth inches	USDA tex	% rock	% Saturation	%Carbon	AWC in/in"	% Volume**	K Factor***
GVH11A	0-8	sicl	13	38.13	3.9	0.12-0.13	13.7	0.32
GVH11A	8 to 20	sicl	23	31.44	1.9	0.16-0.18	11.1	0.17
GVH11A	20-34	sicl	35	31.39	1.8	0.16-0.18	10.6	0.15
GVH11B	0-8	sicl	25	37.5	3.5	0.12-0.13	10.6	0.2
GVH11B	8 to 17	sicl	30	33.15	3.4	0.16-0.18	9.3	0.17
GHV11B	17-25	cl	40	33.49	1.6	0.16-0.18	2.5	0.1
GVH12	0-6	cl	25	35.38	2	0.12-0.16	10.6	0.2
GVH12	6 to 12	sil	40	30.97	1.2	0.12-0.14	5.5	0.1
GVH13A	0-7	cl	2	36.16	3.3	0.15-0.18	13.5	0.37
GVH13A	7 to 20	cl	8	32.57	1.4	0.14-0.16	12.3	0.24
GVH13A	20-34	cl	15	29.38	1.1	0.15-0.18	10.8	0.17
GVH13A	34-60	cl	50	26.31	0.5	0.15-0.18	3.9	0.1
GVH13B	0-9	cl	0	34.59	2.6	0.15-0.18	14	0.37
GVH13B	9 to 24	cl	0	32.54	1.9	0.14-0.16	14	0.32
GVH13B	24-40	clay	25	30.33	0.6	0.15-0.20	7.5	0.15
GVH13B	40-60	cl	35	25.87	0.4	0.15-0.20	6.6	0.1
GVH14	0-9	cl	0	37.21	3.3	0.15-0.18	14	0.37
GVH14	9 to 21	cl	2	29.59	1.6	0.14-0.16	13.5	0.32
GVH14	21-45	sicl	3	30.11	1.4	0.15-0.20	16.2	0.32
GVH14	45-60	cl	2	29.93	1.1	0.15-0.20	13.5	0.32
GVH15A	0-8	sicl	0	32.6	1.9	0.15-0.18	14	0.32
GVH15A	8 to 18	sicl	4	32.7	3	0.14-0.16	16	0.32
GVH15A	18-30	sic	7	31.86	1.4	0.14-0.16	12.5	0.2
GVH15A	30-54	cl	25	24.23	0.3	0.15-0.20	8.7	0.2
GVH16A	0-6	cl	0	37.55	1.3	0.15-0.18	14	0.37
GVH16A	6 to 15	sic	0	33.74	2	0.14-0.16	14	0.28
GVH16A	15-24	clay	0	30.24	1.6	0.14-0.16	12	0.2
GVH16A	24-40	sic	5	30.27	1.4	0.15-0.20	12.3	0.2
GVH16B	0-7	cl	0	35.84	1	0.12-0.13	14	0.37
GVH16B	7 to 14	cl	10	31.42	2.2	0.16-0.18	11.9	0.32
GVH16B	14-24	cl	20	29.85	1.6	0.16-0.18	9.8	0.17
GVH17	0-9	cl	0	37.69	3	0.15-0.18	14	0.37
GVH17	9 to 18	cl	0	33.89	1.9	0.14-0.16	14	0.32
GVH17	18-32	clay	5	30.18	0.8	0.14-0.16	11.9	0.2
GVH17	32-50	clay	12	34.78	0.4	0.15-0.20	9.8	0.2

\*\*the second figure in this column is derived from SPAW Model, 2005 K.E. Saxton and W.J. Rawls. With adjustments for Coarse fragments in soil.

\*\* Ibid. From Table 12, page 280. Soil Survey of Carbon Area, Utah. June 1988( Jensen and Borchert)

The values estimated for K Factor are corrected for coarse fragment contents and salts, and were all less than 0.37, within the good category rating for soil erosion potential. Plant Available water content for these soils, when estimated from the Saxton model, then corrected for coarse fragment content, range between a low of 2-4% volume plane available water for sites 11B and 13A and a high of 14% in several sites (GVH-13B, GVH-14, GVH-15A, GVH17). Most of the plant available water volume ranges between 8-12 % for topsoil at these sites.

## SUITABILITY ASSESSMENT AND SUMMARY

Table 3 provides estimates in cubic yards for the amount of suitable topsoil and available substitute subsoil that may be recovered from each of the seven proposed Gas Vent Borehole sites. Where more than one soil pedon represents a one acre site, the proportions of each soil type are weighted then averaged into the cubic yard calculation for salvageable soil.

TABLE 3

Drill site	% of One Acre	Avg. Topsoil depth	Acreage Covered	Cubic Yards Soil
GVH11A	30	20 inches	13,068	807
GVH11B	70	17 inches	31,892	1673
GVH12	100	6 inches	43,560	807
GVH13A	40	20 inches	17,424	1076
GVH13B	60	24 inches	26,136	968
GVH14	100	21 inches	43,560	2823
GVH15A	60	18 inches	26,136	1452
GVH15B	40	6 inches	17,424	323
GVH16A	30	24 inches	13,068	968
GVH16B	70	14 inches	31,892	1378
GVH17	100	18 inches	43,560	2420

### Sites with available substitute materials      Avg. subsoil Material

GVH13A	40	14 inches	17,424	724
GVH14	100	24 inches	43,560	3227
GVH15A	60	12 inches	26,136	968

Cubic yard salvageable soil estimates from the above table range between 800 and 1700 in the shallow to bedrock Beje Series soils (GVH12, GVH15) to amounts up to 2500 cubic yards of salvageable topsoil averaged over a one-acre drillsite in the Millerlake Series soil types (GVH14, GVH16, GVH17). An additional amount of between 724 and 3227 cubic yards substitute subsoil material may be salvaged from sites GVH 13A, GVH14, and GVH15A, and used to compensate for the deficiencies in soil volume on ridgetops, stony shallow soils, and on convex slopes with many rocks. A qualified soil scientist with an understanding of the soil distribution at each site should be present to direct the soil salvage operations.

In conclusion, 11 soil pedons were described along a transect of seven proposed Gas Vent Borehole sites in September, 2006. Ten of these sites were sampled for criteria specified in Guidelines for Management of Topsoil and Overburden. Of these analytical test, the only limitations to use of these materials for topsoil and substitute topsoil are the clay contents in some of the subsoil, CaCo3 percentages in several subsurface horizons, and several lower than 6.0 pH subsoil horizons at one of the drillsites (GVH-16). Chemical and physical properties of all the the topsoil sampled, ranging from 6 to 24 inch depths, are rated as suitable in all other parameters tested. There are no limitations with regard to slope steepness, plant nutrition, or rock fragment content in these soils. Several of the ridgetop positions in the area have less than 6 inches of available topsoil material, but compensation for this may be made by using subsoil from concave sideslopes found nearby. Site GVH12 has the least amount of suitable topsoil within the panel described in this report.

The amount of salvageable topsoil at each of these sites varies considerably, with the Beje Series found on sparsely vegetated ridgetops and convex steep sideslopes providing much less salvageable material than the aspen groves found within sideslope, concave, and toeslope positions (Millerlake and Aagard Series) which have as much as 2800 cubic yards of salvageable topsoil per acre available.

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## Appendix 1. BYU Soil Laboratory Analysis



Sample Site	Soil Depth (in.)	Lab #	Sand (%)	Clay (%)	Silt (%)	Texture <sup>2</sup>	Very Fine Sand	Extractable K mg/kg	Saturation %	pH	EC @ 25 C ds/m	CaCO <sub>3</sub> %	Organic Matter % * 4/1/12	Calcium meq/L
GVH-11A	0-8	s6 668	17.72	31.84	50.44	Silty Clay Loam	11.08	316.80	38.13	7.55	0.79	0.00	6.76	6.80
GVH-11A	8-20"	669	14.72	35.84	49.44	Silty Clay Loam	12.32	201.60	31.44	7.53	0.73	3.03	3.31	7.06
GVH-11A	20-34"	670	16.72	36.20	47.08	Silty Clay Loam	13.66	131.20	31.39	7.56	0.72	9.51	3.01	6.91
GVH-11B	0-8"	671	15.72	33.84	50.44	Silty Clay Loam	12.64	374.40	37.50	7.44	0.67	1.60	6.03	4.42
GVH-11B	8-17"	672	17.72	32.20	50.08	Silty Clay Loam	15.70	137.60	33.15	7.09	0.47	1.18	5.78	3.70
GVH-11B	17-25"	673	20.36	34.20	45.44	Clay Loam	17.54	112.00	33.49	6.85	0.81	3.84	2.71	8.07
GVH-12	0-6"	674	23.72	29.84	46.44	Clay Loam	12.46	441.60	35.38	7.32	0.82	6.23	3.51	6.45
GVH-12	6-12"	675	17.72	37.84	44.44	Silty Clay Loam	12.62	147.20	30.97	7.21	1.00	9.50	2.17	9.03
GVH-13A	0-7"	676	26.72	29.84	43.44	Clay Loam	15.88	364.80	36.16	6.72	0.71	1.10	5.62	4.86
GVH-13A	7-20"	677	25.72	34.20	40.08	Clay Loam	16.38	185.60	32.57	7.18	0.55	0.98	2.39	4.14
GVH-13A	20-34"	678	24.72	36.20	39.08	Clay Loam	14.56	92.80	29.38	7.60	0.38	7.68	1.88	2.66
GVH-13A	34-60"	679	22.44	38.20	39.36	Clay Loam	11.82	54.40	26.31	7.77	0.37	36.51	0.80	1.95
GVH-13B	0-9"	680	27.08	32.20	40.72	Clay Loam	18.28	294.40	34.59	6.66	0.47	0.33	4.47	2.54
GVH-13B	9-24"	681	23.08	34.56	42.36	Clay Loam	15.34	300.80	32.54	7.04	0.52	0.55	3.19	2.88
GVH-13B	24-40"	682	23.44	40.56	36.00	Clay	17.22	86.40	30.33	7.46	0.32	2.66	1.04	1.58
GVH-13B	40-60"	683	22.44	34.56	43.00	Clay Loam	14.82	64.00	25.87	7.78	0.37	28.46	0.62	2.02
GVH-14	0-9"	684	23.44	30.56	46.00	Clay Loam	17.54	486.40	37.21	7.10	0.59	0.84	5.63	4.14
GVH-14	9-21"	685	22.44	36.20	41.36	Clay Loam	18.42	400.00	29.59	7.14	0.70	0.85	2.85	2.68
GVH-14	21-45"	686	18.44	36.20	45.36	Silty Clay Loam	14.10	224.00	30.11	6.98	0.38	0.69	2.36	0.97
GVH-14	45-60"	687	21.44	34.56	44.00	Clay Loam	17.50	172.80	29.93	7.34	0.31	0.65	1.82	0.65
GVH-15A	0-8"	688	19.44	41.56	39.00	Silty Clay	14.80	201.60	32.60	7.43	0.48	8.16	3.36	0.54
GVH-15A	8-18"	689	29.44	34.56	36.00	Silty Clay Loam	19.58	371.20	32.70	7.29	0.53	2.05	5.12	0.78
GVH-15A	18-30"	690	20.44	40.56	39.00	Silty Clay	15.24	176.00	31.86	7.93	0.44	9.41	2.50	0.63
GVH-15A	30-54"	691	24.44	35.56	40.00	Clay Loam	8.92	92.80	24.23	7.84	0.36	51.68	0.44	0.62
GVH-16A	0-6"	692	23.44	35.56	41.00	Clay Loam	16.52	512.00	37.55	6.55	1.00	0.83	2.32	0.68
GVH-16A	6-15"	693	19.44	40.56	40.00	Silty Clay	15.14	288.00	33.74	6.05	0.26	0.24	3.48	0.58
GVH-16A	15-24"	694	23.44	43.56	33.00	Clay	19.22	204.80						

Bruce L. Webb, Director Soil Analysis Lab

$$(TR_{2,1}) = (V_{2,1})_{\text{eff}} N_{\text{eff}} \approx 0.172 \approx 0.0$$

Cations (mg/kg)										
Sample Site	Soil Depth (in.)	Lab #	Magnesium meq/L	Potassium meq/L	Sodium meq/L	SAR	Available P mg/kg	Available Nitrogen Nitrate mg/kg		
GVH-11A	0-8	s6 668	0.43	0.63	0.85	0.45	22.82	3.61		
GVH-11A	8-20"	669	0.41	0.46	0.66	0.34	13.83	0.94		
GVH-11A	20-34"	670	0.31	0.18	0.54	0.28	9.16	0.80		
GVH-11B	0-8"	671	0.37	1.01	0.83	0.54	47.31	4.85		
GVH-11B	8-17"	672	0.24	0.20	0.60	0.43	33.93	1.92		
GVH-11B	17-25"	673	0.32	0.17	0.50	0.24	24.58	1.09		
GVH-12	0-6"	674	0.61	1.37	0.54	0.29	32.53	6.78		
GVH-12	6-12"	675	0.88	0.28	0.97	0.43	8.53	5.73		
GVH-13A	0-7"	676	0.80	0.90	0.76	0.45	48.62	12.65		
GVH-13A	7-20"	677	0.76	0.30	1.30	0.83	31.65	2.19		
GVH-13A	20-34"	678	0.59	0.12	1.15	0.90	24.32	2.34		
GVH-13A	34-60"	679	0.32	0.07	0.49	0.46	18.86	3.14		
GVH-13B	0-9"	680	0.64	0.60	0.69	0.55	32.73	6.99		
GVH-13B	9-24"	681	0.72	0.62	0.77	0.58	33.03	4.00		
GVH-13B	24-40"	682	0.33	0.09	0.63	0.65	29.56	3.93		
GVH-13B	40-60"	683	0.47	0.09	0.74	0.67	23.99	4.95		
GVH-14	0-9"	684	0.64	1.39	0.84	0.54	50.38	10.75		
GVH-14	9-21"	685	0.64	0.93	1.31	1.02	43.55	6.96		
GVH-14	21-45"	686	2.13	0.34	0.26	0.21	36.95	6.14		
GVH-14	45-60"	687	2.07	0.23	0.21	0.18	40.72	2.58		
GVH-15A	0-8"	688	4.95	0.31	0.22	0.13	9.36	2.13		
GVH-15A	8-18"	689	7.71	1.01	0.31	0.15	17.50	4.19		
GVH-15A	18-30"	690	4.40	0.27	0.21	0.13	11.38	1.23		
GVH-15A	30-54"	691	3.75	0.09	0.20	0.14	15.88	4.36		
GVH-16A	0-6"	692	9.24	2.26	0.64	0.29	67.93	38.52		
GVH-16A	6-15"	693	1.21	0.46	0.16	0.17	36.42	8.81		
GVH-16A	15-24"	694	0.80	0.21	0.11	0.14	31.75	5.56		
GVH-16A	24-40"	695	0.61	0.15	0.09	0.12	22.25	6.21		
GVH-16B	0-7"	696	2.13	0.89	0.17	0.15	46.02	10.14		
GVH-16B	7-14"	697	1.85	0.68	0.21	0.20	30.50	2.10		
GVH-16B	14-24"	698	0.76	0.18	0.11	0.14	20.25	6.74		
GVH-17	0-9"	699	6.99	0.88	0.31	0.16	23.07	8.05		
GVH-17	9-18"	700	7.39	0.42	0.31	0.15	10.00	6.18		
GVH-17	18-32"	701	1.93	0.14	0.21	0.18	13.48	4.85		
GVH-17	32-50"	702	1.51	0.09	0.18	0.18	16.17	4.78		
SP3- Savage	15-30"	708	106.67	34.20	3133.22	397.39				
SP3- Savage	0-15	709	768.00	9.65	7965.22	401.50				

Appendix 2. Bruce Chesler's Soil Pedon Descriptions

and Site Sketches

For GVH 11-17







USDA - Forest Service  
1. Map Unit Symbol: SENLWERT, STONY  
2. Family or Series: PACIFIC HARDWOOD, LUMBY-SWEET  
3. Date: 8/24/64  
4. By: 8384  
5. Photo. No.: 118  
6. Stop No.: 118  
7. USGS Quad: M4000  
8. Location: LONG  
9. Area: EMMA PARK BOONCHIFFS  
10. Forest: BACKHOLE PIT  
11. Ranger District: 12. State: 13. County: CARBON  
14. Parent Material: RESIDUUM  
15. Bedrock Name: CALCAREOUS SANDSTONE  
16. Elevation: 8350 ft  
17. Erosion: a. Kind: NONE b. Class: NONE  
18. Landform: SLOPE  
19. Slope: a. %: 19 b. Shape: c. Length: 75' d. Aspect: 150  
20. Drainage Class: WEL  
21. Surface Stone and Rock: a. GR: 0 b. CB: 0 c. ST: 5 d. BY: 8  
22. Potential Natural Vegetation: ASPEN, SNOWBERRY, WYOMIAL BIRCH  
23. Annual Precipitation: 18" 24. Measured Soil Temperature: 25. Water Table (Depth): 26. Partial Size-Control Section: a. Depth: 10-25" b. Average Clay %: 33 c. Average Rock Fragment Content: 73.5% 27. Depth to Lithic or Paralitric Contact: 28. Diagnostic Horizons: a. Surface: PACIFIC b. Subsurface: CAMBIC c. Moist Control Section Depth: 10-25" 29. Moist Control Section Depth: 10-25"

HORI- ZON DE- SIGNA- TION	INCHES DEPTH	COLOR		LAB TEXTURE	STRUC- TURE	CONSISTENCE			SPECIAL FEATURES					EFFER. CLASS	LAB FIELD pH	BOUNDARY
		Moist	Dry			Dry	Moist	Wet	Cutans	% of Rock Fragments	Roots	Pores				
A	0-8	10YR 2 1/2	10YR 4/2	/	ZM GR	SD	VFR	SS/PS	/	GR-10	3VF	3VF IN	NE	7.4	C.W	
AB	8-17	10YR 3/2	10YR 4/2	/	ZM-F SBN	SH	F1	S/P	/	GR-10	2VF	2VF IN	SE	7.1	G.W	
Bw	17-25	10YR 3/3	10YR 4/3	/	ZM SBN	SH	F1	VS/P	/	GR-10	2VF	2VF IN	SE	6.9	C.S	
R	25	HARD SANDSTONE BEDROCK														







USDA Forest Service SOIL DESCRIPTION (Ref: 11-2509.10)

1. Map Unit Symbol: A-60, CLAY SUBSOIL

2. Family or Series: CALIC PACIFIC AGGREGATE, FINE

3. Date: 9/24/04

4. By: JBC

5. Photo No.: 7778

6. Stop No.: GVH-133

7. USGS Quad: MADE

8. Location: LAT 39° 21' N, LONG 110° 09' W

9. Area: BOOKCLIFF SUMMIT

10. Forest: BACHIADE PIT

11. Ranger District: 12. State: 13. County: CARBON

14. Parent Material: PRESSIONUM

15. Bedrock Name: CALC. SANDSTONE

16. Elevation: 8150 FT

17. Erosion: NONE TO SLIGHT

18. Landform: MOUNTAIN SLOPE

19. Slope: a. % 25, b. Shape CONCAVE, c. Length 60 FT, d. Aspect 15°

20. Drainage Class: WELL

21. Surface Stone and Rock: a. CR 10, b. CB 2, c. ST 5, d. BY 8

22. Potential Natural Vegetation: ASPEN, SNOWBERRY

23. Annual Precipitation: 18"

24. Measured Soil Temperature: CRAYIC

25. Water Table (Depth): NONE

HORI- ZON	INCL- DE- SIGNA- TION	COLOR			TEXTURE	STRUC- TURE	CONSISTENCE			SPECIAL FEATURES				EFFER. CLASS	LAB FIELD #	BOUNDARY
		Moist	Dry	Mottling			Dry	Moist	Wet	Cutans	% of Rock Fragments	Roots	Poros			
Di	1/2-0	DISCONTINUOUS LENS														
A	0-9	10YR 3/2	10YR 5/2	/	CL	2M, F GR	SO	VF	SS/PS	/						
BAT	9-24	10YR 3/3	10YR 5/3	/	CL	2F, BK MGR	SL	F1	S/P	/						
Bt2	24-40	7.5YR 5/4	7.5YR 6/4	/	2B1 CLAY	2M-F SBK	SL	F1	S/P	2APF LAPD						
Bt4	40-60	10YR 5/3	10YR 7/3	/	41 VST CL	3M-M ABK	SL	F1	S/P	2APD						

26. Partical Size Control Section: a. Depth: 24-44, b. Average Clay %: 37, c. Average Rock Fragment Content: 28

27. Depth to Lithic or Paralitric Contact: >60

28. Diagnostic Horizons: a. Surface: PACIFIC, b. Subsurface: ARGILLIE

29. Moist Control Section Depth: 10-30









1. Map Unit Symbol	2. Family or Series	3. Date	4. By	5. Photo. No.	6. Stop No.	7. USGS Quad	8. Location:
9. Area Boundaries	10. Form	11. Ranger District	12. State	13. County	14. Elevation	15. Bedrock Name	16. Class
17. Parent Material	18. Landform	19. Slope: a. % b. Shape	20. Drainage Class	21. Surface Stone and Rock	22. Potential Natural Vegetation	23. Annual Precipitation	24. Measured Soil Temperature
25. Horizon	26. Depth	27. Moisture	28. Color	29. Texture	30. Structure	31. Consistency	32. Special Features
33. Moist	34. Dry	35. Mottling	36. LAB TEXTURE (d) %C	37. STRUC-TURE (e)	38. Wet	39. Roots	40. Pores
41. EFFER. CLASS	42. FIELD pH	43. BOUNDARY	44. LAB	45. ROOTS	46. PORES	47. EFFER. CLASS	48. BOUNDARY
49. 0-10	50. 10-20	51. 20-30	52. 30-40	53. 40-50	54. 50-60	55. 60-70	56. 70-80
57. 80-90	58. 90-100	59. 100-110	60. 110-120	61. 120-130	62. 130-140	63. 140-150	64. 150-160
65. 160-170	66. 170-180	67. 180-190	68. 190-200	69. 200-210	70. 210-220	71. 220-230	72. 230-240
73. 240-250	74. 250-260	75. 260-270	76. 270-280	77. 280-290	78. 290-300	79. 300-310	80. 310-320
81. 320-330	82. 330-340	83. 340-350	84. 350-360	85. 360-370	86. 370-380	87. 380-390	88. 390-400
89. 400-410	90. 410-420	91. 420-430	92. 430-440	93. 440-450	94. 450-460	95. 460-470	96. 470-480
97. 480-490	98. 490-500	99. 500-510	100. 510-520	101. 520-530	102. 530-540	103. 540-550	104. 550-560
105. 560-570	106. 570-580	107. 580-590	108. 590-600	109. 600-610	110. 610-620	111. 620-630	112. 630-640
113. 640-650	114. 650-660	115. 660-670	116. 670-680	117. 680-690	118. 690-700	119. 700-710	120. 710-720
121. 720-730	122. 730-740	123. 740-750	124. 750-760	125. 760-770	126. 770-780	127. 780-790	128. 790-800
129. 800-810	130. 810-820	131. 820-830	132. 830-840	133. 840-850	134. 850-860	135. 860-870	136. 870-880
137. 880-890	138. 890-900	139. 900-910	140. 910-920	141. 920-930	142. 930-940	143. 940-950	144. 950-960
145. 960-970	146. 970-980	147. 980-990	148. 990-1000	149. 1000-1010	150. 1010-1020	151. 1020-1030	152. 1030-1040
153. 1040-1050	154. 1050-1060	155. 1060-1070	156. 1070-1080	157. 1080-1090	158. 1090-1100	159. 1100-1110	160. 1110-1120
161. 1120-1130	162. 1130-1140	163. 1140-1150	164. 1150-1160	165. 1160-1170	166. 1170-1180	167. 1180-1190	168. 1190-1200
169. 1200-1210	170. 1210-1220	171. 1220-1230	172. 1230-1240	173. 1240-1250	174. 1250-1260	175. 1260-1270	176. 1270-1280
177. 1280-1290	178. 1290-1300	179. 1300-1310	180. 1310-1320	181. 1320-1330	182. 1330-1340	183. 1340-1350	184. 1350-1360
185. 1360-1370	186. 1370-1380	187. 1380-1390	188. 1390-1400	189. 1400-1410	190. 1410-1420	191. 1420-1430	192. 1430-1440
193. 1440-1450	194. 1450-1460	195. 1460-1470	196. 1470-1480	197. 1480-1490	198. 1490-1500	199. 1500-1510	200. 1510-1520
201. 1520-1530	202. 1530-1540	203. 1540-1550	204. 1550-1560	205. 1560-1570	206. 1570-1580	207. 1580-1590	208. 1590-1600
209. 1600-1610	210. 1610-1620	211. 1620-1630	212. 1630-1640	213. 1640-1650	214. 1650-1660	215. 1660-1670	216. 1670-1680
217. 1680-1690	218. 1690-1700	219. 1700-1710	220. 1710-1720	221. 1720-1730	222. 1730-1740	223. 1740-1750	224. 1750-1760
225. 1760-1770	226. 1770-1780	227. 1780-1790	228. 1790-1800	229. 180			



















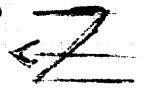








0 25 50 FT.



GVH-11

TO TOWER MILE  
~ 3 MILES  
GRADED ROAD  $\frac{3}{4}$  MILES

0 25 50

GVH-12

Moose Family

Mother Family  
GVH-11A

5-9/10  
to water

GVH-1B

Study Phase  
GVH-1B

10-15/5  
to water

JEOP ROAD  
TO: BUNKER  
TO: POND

STEPPERS  
75% success

8-12/10  
to water

GVH-12  
Study Phase

13-14/10  
to water

to water

to water

to water

MIXED ASPEN CANOPY

w/ SURBS

AUGERED  
25" A-BX

↑ TOSSON BEAR

APACHE SERIES  
CANYON CREEK

AUGERED  
15" POKES

GVH-13B  
A

15-25%  
SURBS

SURBS  
BROWN

APACHE SERIES  
GVH-13A  
A

10-25%  
SURBS

BRIDGE RUN 3/4 Mile  
Down Creek

MILNER LAKE, CANYON  
GVH-14  
A

0-7' A1  
7-20' A2

< 10%  
SLOPES

0-3%  
SLOPES

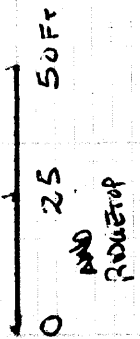
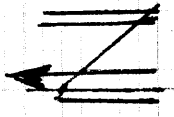
AUGERED  
15" A-BX

AUGERED  
15" A-BX

GVH-14

15-20%  
SURBS

GVH-13





15% ASPEN CANOPY

PIVET  
0.8" P  
8  
10-15%

SLOPES  
10-15%

SLOPES  
5-10%  
ASPER  
AND SCATTERED

10-15%  
PIVET

GNH-16A CUPED  
MINERAL LIME, PIVET

10-15%  
PIVET  
AND SCATTERED

GNH-16B  
POTRUEE FAMILY  
SLOPES  
15-25%

GNH-16

SAUERBRUSH

W RABBIT BRUSH  
SERVICERARY

PIVET  
0.8" P  
8  
10-15%

SLOPES  
15-25%

GNH-15A  
PIVET  
AND SCATTERED

SLOPE  
5%

GNH-15B  
BEJE SERIES

SLOPE  
BETTER

PIVET  
0.8" P  
8  
10-15%

TO  
GNH-14

GNH-15

TEEP ROAD

0 25 50 FT.

2115 HANOVER RD. N

Aug 8  
0-8 ft  
8-24 ft

MILLER, L. L.  
AUG 11-17  
MILLER, L. L.

15-20%  
SLOPES

10-15%  
SLOPES

STONY  
DITCH

2025  
AUG 25

Aug 12  
0-12 ft  
12-26 ft

To  
Road

Valley Floor

Grass



GNH-17



### Appendix 3. Soil Series Used in Correlation with this Report

LOCATION SENCHERT

UT

Established Series  
REV: EJ/JMD/RLM  
02/1999

## SENCHERT SERIES

The Senchert series consists of moderately deep, well drained, moderately permeable soils that formed in alluvium and colluvium derived dominantly from sandstone and shale. These soils are on mountainsides, ridges and plateaus. Slopes range from 1 to 50 percent. Mean annual temperature is 37 degrees F. and average annual precipitation is 22 inches.

**TAXONOMIC CLASS:** Fine-loamy, mixed, superactive Pachic Argicryolls

**0--3 inches to 0;** somewhat decomposed leaves and twigs.

**A--0 to 4 inches;** very dark grayish brown (10YR 3/2) loam, very dark brown (10YR 2/2) moist; moderate medium granular structure; soft, very friable; few fine and very fine roots; neutral (pH 7.2); abrupt smooth boundary. (2 to 11 inches thick)

**Bt1--4 to 9 inches;** brown (10YR 4/3) loam, very dark grayish brown (10YR 3/2) moist; moderate medium subangular blocky structure; hard, firm, slightly sticky and slightly plastic; few fine medium and coarse roots; few very fine and fine pores; few thin clay films on faces of peds and in pores; neutral (pH 7.2); clear smooth boundary. (4 to 16 inches thick)

**Bt2--9 to 16 inches;** brown (10YR 5/3) loam, very dark grayish brown (10YR 3/2) moist; moderate medium subangular blocky structure; very hard, firm, slightly sticky and slightly plastic; few very fine, fine and medium roots; few very fine and fine pores; common, moderately thick clay films on faces of peds and in pores; mildly alkaline (pH 7.6); clear smooth boundary. (0 to 16 inches thick)

**Bt3--16 to 35 inches;** brown (10YR 5/3) clay loam, very dark grayish brown (10YR 3/2) moist; weak medium subangular blocky structure; hard, firm, sticky and plastic; few very fine, fine and medium roots; few very fine and fine pores; few thin clay films on faces of peds and in pores; mildly alkaline (pH 7.6); abrupt smooth boundary. (0 to 19 inches thick)

**R--35 inches;** calcareous sandstone.

**TYPE LOCATION:** Carbon County, Utah, about 10 miles north and 2 miles west of East Carbon City; about 2,700 feet south and 1,000 feet east of the NW corner of sec. 4., T. 16 S., R. 16 E.

**RANGE IN CHARACTERISTICS:** The mollic epipedon and the solum are 16 to 35 inches thick. Depth to bedrock is 20 to 40 inches. Mean annual soil temperature ranges from 38 to 40 degrees F. The mean summer soil temperature is 44 to 47 degrees F.

The A horizon has value of 3 through 5 dry, 2 or 3 moist and chroma of 2 or 3. Clay content is 10 to 24 percent.

The Bt horizon has value of 4 or 5 dry and chroma of 2 or 3. Texture is loam or clay loam. Rock fragment content is 0 to 15 percent, which is mostly pebbles. Clay content is 18 to 35 percent. Reaction is neutral to mildly alkaline.

The C horizon where present is clay loam or silty clay.

**COMPETING SERIES:** These are Bachus, Benteen, Cambern, Clayburn, Decross, Demast, Dranyon, Echemoor, Gordo, Harmehl, Stubbs, Thulepah, and Winu series. Benteen soils have 20 to 40 percent limestone fragments in the lower profile. Cambern soils contain ash and tuff in the profile. Clayburn, Decross, Demast, Dranyon, Gordo, Thulepah soils lack bedrock within depths of 40 inches. Echemoor and Stubbs soils have paralithic contacts at depths of 20 to 40 inches. Harmehl and Winu soils have 15 to 35 percent rock fragments in the argillic horizon. Bachus soils are medium acid or slightly acid.

**GEOGRAPHIC SETTING:** Senchert soils are on mountainsides, ridges, plateaus and benches. Slopes are 1 to 50 percent. The soils formed in alluvium and colluvium from sandstone, shale, and siltstone. The elevation is 7,200 to 10,100 feet. The mean annual temperature is 36 to 38 degrees F. The average annual precipitation is 20 to 30 inches.

**GEOGRAPHICALLY ASSOCIATED SOILS:** These are Beenon, <sup>M TROZE</sup> Troze and Trag soils. Beenon and Trag soils are associated with Senchert at the lower elevation and have mean annual temperature of 38 to 42 degrees F. Beenon soils are shallow and Trag soils are deep. Troze soils lack argillic horizon and have calcic horizon.

**DRAINAGE AND PERMEABILITY:** Well drained; runoff is slow or medium; moderate permeability.

**USE AND VEGETATION:** Rangeland and wildlife habitat. Some areas have been used for woodland. Present vegetation is Douglas-fir, Englemann spruce, white fir, quaking aspen, mountain big sagebrush, snowberry, and Thurber fescue.

**DISTRIBUTION AND EXTENT:** The Senchert soils are moderately extensive. They are in the high mountain areas of Carbon County, Utah.

**MLRA OFFICE RESPONSIBLE:** Lakewood, Colorado

**SERIES ESTABLISHED:** Carbon County, Utah, 1982 The name of this series is coined.

**REMARKS:**

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National Cooperative Soil Survey  
U.S.A.

LOCATION ROTTULEE

MT+UT

Established Series  
Rev. JCM/CAM/JEB  
02/1999

## ROTTULEE SERIES

The soils of the Rottulee series are well-drained, moderately deep soils over shattered limestone. They are on shale and limestone bedrock uplands. The mean annual precipitation is about 18 inches and the mean annual air temperature is about 42 degrees F.

**TAXONOMIC CLASS:** Fine-loamy, mixed, superactive, frigid Entic Haplustolls

**TYPICAL PEDON:** Rottulee silt loam, grassland. (Colors are for dry soil unless otherwise noted.)

**A1**--0 to 2 inches; dark-brown (7.5YR 4/2) silt loam, dark brown (7.5YR 3.2) when moist; weak, thin, platy structure; slightly hard, very friable, slightly sticky and slightly plastic; many very fine roots and tubular pores; moderately calcareous; clear, smooth boundary. (2 to 5 inches thick)

**B1**--2 to 6 inches; reddish-brown (5YR 5/3) silt loam, dark reddish brown (5YR 3/3) when moist; weak, medium, prismatic structure; slightly hard, very friable, slightly sticky and plastic; common very fine roots; common fine and very fine tubular pores; moderately calcareous; clear, wavy boundary. (2 to 6 inches thick)

**B2**--6 to 10 inches; light reddish-brown (5YR 6/3) heavy silt loam, reddish brown (5YR 4/4) when moist; moderate, medium, prismatic structure; hard, friable, sticky and plastic; common very fine roots; common fine and very fine tubular pores; moderately calcareous; clear, wavy boundary. (3 to 7 inches thick)

**B3**--10 to 15 inches; light reddish-brown (5YR 6/3) heavy silt loam, reddish brown (5YR 4/4) when moist; moderate, medium and fine, blocky structure; hard, friable, sticky and plastic; common very fine roots and tubular pores; strongly calcareous with a few threads of segregated lime; clear, wavy boundary. (4 to 8 inches thick)

**Cca**--15 to 22 inches; light reddish-brown (5YR 6/4) gravelly light clay loam, yellowish red (5YR 5/6) when moist; weak, fine, blocky structure; hard, friable, slightly sticky and slightly plastic; common very fine roots and tubular pores; 20 percent (volume) shale fragments; strongly calcareous; common fine threads of segregated lime; gradual boundary.

**R**--22 inches, shattered limestone.

**TYPE LOCATION:** Big Horn County, Montana; 660 feet north and 220 feet east of the SW corner of sec. 18, T.8S., R.33E.

**RANGE IN CHARACTERISTICS:** The control section is silt loam, loam, light silty clay loam, or light clay loam with 20 to 34 percent clay and 15 to 25 percent fine or medium sand and with gravel-size shale fragments increasing to as much as 30 percent just above the bedrock. The soil is weakly to strongly calcareous with increasing quantity of lime with increased depth above the bedrock. The soil has hue of 7.5YR through 10R. Mean annual soil temperature ranges from 44 to 47 degrees F., and average summer soil temperature ranges from 59 to 65 degrees F.

The Cca horizon has few to common films and threads of lime or few masses of accumulated flour lime. It contains 8 to 15 percent (estimated) CaCO<sub>3</sub> equivalent.

**COMPETING SERIES:** These are the Amor, Bynum, Darret, Duffy, Max, Peritsa, Prospect, Quigley, Searing, Shambo and Twin Creek series. Amor and Peritsa soils have a paralithic contact at depths of 20 to 40 inches. Bynum soils have average summer soil temperature of 52 to 58 degrees F. and have hue of 10YR or 2.5Y. Darret soils have an argillic horizon. Duffy, Max, Prospect and Quigley soils have hue of 10YR through 5Y. Max, Prospect, Quigley, Shambo and Twin Creek soils lack bedrock within depth of 40 inches. Searing soils are noncalcareous to depths of 10 to 24 inches.

**GEOGRAPHIC SETTING:** Rottulee soils are on gently to strongly rolling red shale and limestone bedrock uplands at elevations of 4,500 to 5,500 feet. The climate is dry-subhumid with mean annual precipitation of 17 to 19 inches, 80 percent of which falls in April through October. The annual temperature ranges from 40 to 45 degrees F. and the mean



summer temperature ranges from 55 to 65 degrees F. The frost-free season ranges from 90 to 110 days.

**GEOGRAPHICALLY ASSOCIATED SOILS:** These are the Abac soils and the competing Peritsa and Twin Creek soils. Abac soils have sandstone at depths shallower than 20 inches.

**DRAINAGE AND PERMEABILITY:** Well-drained; medium runoff; moderate permeability.

**USE AND VEGETATION:** Native range use. Native vegetation is phlox, green needlegrass, prairie junegrass, gayfeather, and bluebunch wheatgrass.

**DISTRIBUTION AND EXTENT:** South-central Montana. The Rottulee series is inextensive.

**MLRA OFFICE RESPONSIBLE:** Lakewood, Colorado

**SERIES ESTABLISHED:** Big Horn County (Big Horn Area), Montana, 1970.

**REMARKS:** The Rottulee soils were formerly classified as Chestnut soils.

OSD scanned by SSQA. Last revised by state on 8/74.

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National Cooperative Soil Survey  
U.S.A.

LOCATION MILLERLAKE

WY+CO

Established Series  
Rev. PSD  
02/1999

## MILLERLAKE SERIES

The Millerlake series consists of deep, well drained soils that formed in slope alluvium and other sediments derived from sedimentary rock. These soils are on fan aprons, terraces, and lower mountain slopes. Slopes are 2 to 35 percent. The mean annual precipitation is about 18 inches, and the mean annual temperature is about 38 degrees F.

**TAXONOMIC CLASS:** Fine-loamy, mixed, superactive Pachic Argicryolls

**TYPICAL PEDON:** Millerlake loam-rangeland. (Colors are for dry soil unless otherwise stated.)

**0--**1 to 0 inch; partially decomposed leaves, grass, and other organic materials.

**A--**0 to 4 inches; dark grayish brown (10YR 4/2) loam, very dark brown (10YR 2/2) moist; strong fine granular structure; soft, very friable, slightly sticky and slightly plastic; many fine and medium roots; neutral (pH 6.8); clear smooth boundary. (3 to 10 inches thick)

**BA--**4 to 7 inches; grayish brown (10YR 5/2) loam, very dark grayish brown (10YR 3/2) moist; moderate medium subangular blocky structure parting to strong medium granular; hard, friable, slightly sticky and slightly plastic; many fine and medium and few coarse roots; few thin clay films on faces of peds and lining pores; neutral (pH 6.8); gradual smooth boundary. (0 to 5 inches thick)

**Bt--**7 to 20 inches; grayish brown (10YR 5/2) clay loam, very dark grayish brown (10YR 3/2) moist; moderate coarse subangular blocky structure parting to strong medium angular blocky; hard, friable, sticky and plastic; many fine and few coarse roots; many moderately thick clay films on faces of peds, and lining pores; neutral (pH 7.2); gradual wavy boundary. (10 to 30 inches thick)

**Btk--**20 to 28 inches; grayish brown (10YR 5/2) loam, dark grayish brown (10YR 4/2) moist; strong coarse subangular blocky structure; very hard, firm, slightly sticky and slightly plastic; few fine and coarse roots; few thin clay films on faces of peds and lining pores; strongly effervescent, lime as common soft masses and as filaments and in seams; moderately alkaline (pH 8.4); gradual wavy boundary. (4 to 10 inches thick)

**Bk--**28 to 60 inches; light gray (10YR 7/2) loam, light brownish gray (10YR 6/2) moist; massive; hard, friable, slightly sticky and slightly plastic; violently effervescent, lime as common soft masses, filaments, and seams; moderately alkaline (pH 8.4).

**TYPE LOCATION:** Carbon County, Wyoming; West quarter corner, sec. 11, T. 18 N., R. 89 W.

**RANGE IN CHARACTERISTICS:** Depth to the base of the argillic horizon is 20 inches or more. Depth to any contrasting material is greater than 40 inches. The mean annual soil temperature ranges from 38 to 42 degrees F., and the mean summer soil temperature ranges from 50 to 56 degrees F. Coarse fragments range from 0 to 15 percent throughout.

The A horizon has hue of 5Y through 7.5YR, value of 3 through 5 dry, 2 or 3 moist, and chroma of 1 through 3. It is slightly acid through mildly alkaline.

The Bt horizon has hue of 5Y through 7.5YR, value of 4 through 6 dry, 2 through 4 moist, and chroma of 1 through 4. It is clay loam or loam with 18 to 35 percent clay and more than 15 but less than 35 percent fine or coarser sand. It is slightly acid through mildly alkaline.

The Btk horizon has hue of 5Y through 7.5YR, value of 5 or 6 dry, 4 or 5 moist, and chroma of 2 through 4. It is loam or clay loam. Carbonates range from 4 to 14 percent. It is moderately alkaline or strongly alkaline.

The Bk horizon has hue of 5Y through 7.5YR, value of 5 through 7 dry, 4 through 6 moist, and chroma of 2 through 4. It is loam or clay loam. Carbonates range from 8 to 14 percent. It is moderately or strongly alkaline.

**COMPETING SERIES:** These are the Bachus, Benteen, Canburn, Clayburn, Decross, Demast, Dranyon, Echemoor, Gordo, Harmehl, Sanchert, Stubbs, Thulepah, and Winu series. The Bachus, Benteen, Canburn, Echemoor, Harmehl, Sanchert, Stubbs, and Winu soils have a lithic or paralithic contact at 20 to 40 inches. Clayburn, Demast, and Thulepah soils do not have Bk horizons. Decross soils have a calcic horizon. Dranyon soils have 20 to 35 percent coarse fragments in the argillic horizon. Gordo soils have hue of 5YR and 2.5YR in the argillic horizon.

**GEOGRAPHIC SETTING:** Millerlake soils are on fan aprons, terraces, and lower mountain footslopes and toeslopes. They formed in slope alluvium and other sediments derived from sedimentary rock. Slopes are 2 to 35 percent. Elevations are 7,800 to 9,500 feet. The mean annual precipitation is about 18 inches and ranges from 15 to 24 inches. The mean annual temperature is about 38 degrees F. and ranges from 34 to 40 degrees F. The frost-free season is less than 60 days.

**GEOGRAPHICALLY ASSOCIATED SOILS:** These are the competing Bachus, Echemoor, and Decross soils. The Bachus and Echemoor soils occur on upslope positions on fan aprons and footslopes. Decross soils occur intermixed with the Millerlake soils.

**DRAINAGE AND PERMEABILITY:** Well drained. Runoff is medium to rapid depending upon slope and surface condition. Permeability is moderately slow.

**USE AND VEGETATION:** Rangeland and wildlife habitat. Native vegetation consists of Idaho fescue, Columbia needlegrass, thickspike wheatgrass, and scattered big sagebrush. Some areas support relatively thick stands of Aspen.

**DISTRIBUTION AND EXTENT:** South central Wyoming and northwestern Colorado. The series is of moderate extent.

**MLRA OFFICE RESPONSIBLE:** Lakewood, Colorado

**SERIES ESTABLISHED:** Aspen-Gypsum Area, Colorado; 1982.

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National Cooperative Soil Survey  
U.S.A.

LOCATION BEJE

UT+CO

Established Series  
Rev. EJ/DKR/TWH  
06/2002

## BEJE SERIES

The Beje series consists of shallow, well drained soils that formed in reworked eolian material, residuum, slope alluvium, and colluvium derived from sandstone and shale. Beje soils are on plateaus, hills, mesas, mountains, ridges, and structural benches. Slopes range from 1 to 50 percent. Mean annual precipitation is about 16 inches and the mean annual temperature is about 42 degrees F.

**TAXONOMIC CLASS:** Loamy, mixed, superactive, frigid Lithic Argiustolls

**TYPICAL PEDON:** Beje loam in rangeland. (Colors are for dry soil unless otherwise noted.)

**A**--0 to 6 inches; brown (10YR 4/3) loam, dark brown (10YR 3/3) moist; weak fine subangular blocky structure; slightly hard, friable, slightly sticky and slightly plastic; common very fine and fine roots; common very fine, fine, and medium pores; slightly alkaline (pH 7.6); abrupt smooth boundary. (2 to 6 inches thick)

**Bt**--6 to 14 inches; brown (10YR 4/3) clay loam, dark brown (10YR 3/3) moist; strong medium subangular blocky structure; hard, firm, moderately sticky and moderately plastic; common very fine, fine, and medium roots; common very fine and fine pores; few faint clay films on faces of peds; slightly alkaline (pH 7.6); abrupt smooth boundary. (6 to 18 inches thick)

**R**--14 inches; sandstone.

**TYPE LOCATION:** Carbon County, Utah; about 12 miles northeast of Price; located about 1,000 feet west and 1,500 feet south of the northeast corner of sec. 19, T. 13 S., R. 12 E.

### RANGE IN CHARACTERISTICS:

Soil moisture: The soil moisture control section is affected by precipitation that is fairly evenly distributed throughout except for July through October being slightly wetter and April through June being slightly drier. Typic ustic moisture regime.

Particle-size control section: 18 to 35 percent clay

Depth to lithic contact: 10 to 20 inches to hard sandstone

Thickness of the mollic epipedon: 7 to 16 inches

#### A horizon:

Hue: 7.5YR or 10YR

Value: 3 or 4 dry, 2 or 3 moist

Chroma: 2 or 3 dry or moist

Rock fragments: 0 to 35 percent sandstone fragments

Reaction: neutral to moderately alkaline

#### Bt horizon:

Hue: 7.5YR or 10YR

Value: 3 to 5 dry, 2 or 4 moist

Chroma: 2 to 4 dry or moist

Texture: clay loam, loam, or sandy clay loam

Rock fragments: 0 to 35 percent sandstone gravel and cobbles

Reaction: neutral to moderately alkaline

**COMPETING SERIES:** These are the Beenom, Berland, Bonjea, Cedric, Coni, Connieo, Kiln, and Viewpoint series.

Berland soils are less than 10 inches deep to a lithic contact.

Beenom soils have soil moisture control sections that are more moist during the spring and drier during the summer.

Cedric soils formed in granite and have accumulations of secondary calcium carbonate.

Coni soils formed in arkosic beds overlying tuff or conglomerate and have granitic rock fragments.

Bonjea and Connico soils formed in granite and have granitic rock fragments.

Kiln soils formed in limestone and have limestone rock fragments.

Viewpoint soils formed in basalt and have basalt-breccia rock fragments.

**GEOGRAPHIC SETTING:**

Parent material: reworked eolian material, residuum, slope alluvium, and colluvium derived from sandstone and shale

Landform: plateaus, hills, mesas, mountains, ridges, and structural benches

Slopes: 1 to 50 percent

Elevation: 6,800 to 9,700 feet

Mean annual temperature: 38 to 47 degrees F

Mean annual precipitation: 14 to 22 inches

Precipitation is fairly evenly distributed throughout the year with July through October being slightly wetter and April through June being slightly dryer.

Frost-free period: 60 to 120 days

**GEOGRAPHICALLY ASSOCIATED SOILS:** These are the Comodore, Rottulee, Senchert and Trag series.

Comodore soils are skeletal. Rottulee and Senchert soils have bedrock at a depth of 20 to 40 inches. Trag soils lack bedrock at depths less than 40 inches.

**DRAINAGE AND PERMEABILITY:** well drained, low to high runoff, moderate or moderately rapid permeability

**USE AND VEGETATION:** These soils are used for rangeland and pinyon-juniper woodland. Present native vegetation is pinyon, juniper, mountain big sagebrush, Salina wildrye, bluebunch wheatgrass and snowberry. This soil at the type location has been correlated to the 048AY436UT Mountain shallow loam (mountain big sage brush) range site.

**DISTRIBUTION AND EXTENT:** South central Utah and southwest Colorado. LRR D, E, MLRA 34, 36, 47, 48A. This series is of moderate extent.

**MLRA OFFICE RESPONSIBLE:** Lakewood, Colorado

**SERIES ESTABLISHED:** Carbon County, Utah. 1982. The name is coined.

**REMARKS:** Diagnostic horizons and features recognized in this pedon are:

Mollic epipedon: The zone from 0 to 6 inches. (A horizon)

Argillic horizon: The zone from 6 to 14 inches. (Bt horizon)

Lithic contact: The contact with sandstone at 14 inches. (R layer)

Particle-size control section: The zone from 0 to 14 inches. (A, Bt horizons)

Keys to Soil Taxonomy: Series classified according to Eighth Edition, 1998.

The lower end of the range of precipitation, at 14 to about 16 inches, may actually be in an aridic ustic moisture regime subclass. This needs further study.

(Revised)  
FEBRUARY 2007

**CHAPTER 3**  
**BIOLOGY**



## TABLE OF CONTENTS

<u>Section</u>	<u>Page</u>
<b>310 INTRODUCTION</b>	<b>3-1</b>
<b>311 Vegetative, Fish and Wildlife Resources</b>	<b>3-1</b>
<b>312 Potential Impacts to Vegetative, Fish and Wildlife Resources</b>	<b>3-1</b>
<b>313 Description of Reclamation Plan</b>	<b>3-1</b>
<b>320 ENVIRONMENTAL DESCRIPTION</b>	<b>3-1</b>
<b>321 Vegetation Information</b>	<b>3-1</b>
321.100 Plant Communities Within the Proposed Permit Area	3-3
321.200 Land Productivity Prior to Mining	3-4
<b>322 Fish and Wildlife Information</b>	<b>3-4</b>
322.100 Level of Detail	3-4
322.200 Site-Specific Resource Information	3-4
322.300 Fish and Wildlife Service Review	3-8
<b>323 Maps and Aerial Photographs</b>	<b>3-8</b>
323.100 Location and Boundary of Proposed Reference Area	3-8
323.200 Elevation and Locations of Monitoring Stations	3-8
323.300 Facilities for Protection and Enhancement	3-8
323.400 Vegetation Type and Plant Communities	3-8
<b>330 OPERATION PLAN</b>	<b>3-8</b>
<b>331 Measures Taken to Disturb the Smallest Area</b>	<b>3-8</b>
<b>332 Description of Anticipated Impacts of Subsidence</b>	<b>3-8</b>
<b>333 Plan to Minimize Disturbances and Adverse Impacts</b>	<b>3-9</b>
333.100 Minimize Disturbance to Endangered or Threatened Species	3-9
333.200 Species and Habitats	3-9
333.300 Protective Measures	3-9

## TABLE OF CONTENTS (Continued)

<u>Section</u>	<u>Page</u>
<b>340 RECLAMATION PLAN</b>	<b>3-9</b>
<b>341 Revegetation</b>	<b>3-9</b>
341.100 Schedule and Timetable	3-10
341.200 Descriptions	3-10
341.300 Greenhouse Studies, Field Trials or Other Equivalent Studies	3-11
<b>342 Fish and Wildlife</b>	<b>3-11</b>
342.100 Enhancement Measures	3-11
342.200 Plants Used for Wildlife Habitat	3-11
342.300 Cropland	3-11
341.400 Residential, Public Service, and Industrial Land Use	3-11
<b>350 PERFORMANCE STANDARDS</b>	<b>3-11</b>
<b>351 General Requirements</b>	<b>3-11</b>
<b>352 Contemporaneous Reclamation</b>	<b>3-11</b>
<b>353 Revegetation: General Requirements</b>	<b>3-11</b>
353.100 Vegetative Cover	3-12
353.200 Reestablished Plant Species	3-12
353.300 Vegetative Exception	3-14
353.400 Cropland	3-14
<b>354 Revegetation: Timing</b>	<b>3-14</b>
<b>355 Revegetation: Mulching and Other Soil Stabilizing Practices</b>	<b>3-14</b>
<b>356 Revegetation: Standards for Success</b>	<b>3-14</b>
356.100 Success of Revegetation	3-14
356.200 Standards for Success	3-15
356.300 Siltation Structures	3-15
356.400 Removal of Siltation Structures	3-15

## TABLE OF CONTENTS (Continued)

<u>Section</u>	<u>Page</u>
<b>357 Revegetation: Extended Responsibility Period</b> .....	<b>3-15</b>
357.100 Extended Period Begins .....	3-15
357.200 Vegetation Parameters .....	3-15
357.300 Husbandry Practices .....	3-16
<b>358 Protection of Fish, Wildlife, and Related Environmental Values</b> .	<b>3-16</b>
358.100 Existence of Endangered or Threatened Species .....	3-16
358.200 Bald and Golden Eagles .....	3-16
358.300 Taking of Endangered or Threatened Species .....	3-16
358.400 Replacement of Wetland or Riparian Vegetation .....	3-16
358.500 Manmade Wildlife Protection Measures .....	3-16

### LIST OF TABLES

<b>Table 3-1</b>	Federal and State Listed T&E Species - Carbon County .....	<b>3-6</b>
<b>Table 3-2</b>	Potential Water Depletion to Colorado River Drainage .....	<b>3-7</b>
<b>Table 3-3</b>	Reclamation Seed Mix .....	<b>3-13</b>

### LIST OF ATTACHMENTS

<b>Attachment 3-1</b>	Vegetation Inventory - Approved Holes GVH-1 through GVH-9
<b>Attachment 3-2</b>	Threatened, Endangered, and Sensitive Species Information
<b>Attachment 3-3</b>	2005 Raptor Survey (Relocated to Confidential Binder)
<b>Attachment 3-4</b>	Photos of GVH Sites
<b>Attachment 3-5</b>	Vegetation Inventory - Proposed Holes GVH-10 through GVH-17

## **310 INTRODUCTION**

This chapter presents a description of the biological resources found on the completed Centennial Project gob gas vent hole sites GVH#1, GVH#3, GVH#4, GVH#5, GVH#6, GVH#5A, GVH#7, GVH#7A, GVH#8, GVH#8A and GVH #9, as well as the proposed sites GVH#10, GVH#10A, GVH#11, GVH#11A, GVH#12, GVH#12A, GVH#13, GVH#13A, GVH#14, GVH#14A, GVH#15, GVH#15A, GVH#16, GVH#16A, GVH#17. Details for each of the sites are provided in this Appendix.

Due to required changes in the mining plan, hole GVH#5B will not be drilled and has been shown as eliminated, although the site has been approved and included in the bonding.

### **311 Vegetation, Fish and Wildlife Resources**

Vegetative, fish, and wildlife resource conditions in and adjacent to the proposed degassification wells are discussed in Section 320 of this submittal and the approved M&RP.

### **312 Potential Impacts to Vegetative, Fish, and Wildlife Resources**

Potential impacts to vegetative, fish, and wildlife resources and the associated mitigation plan is presented in Section 330 and 340 of this chapter.

### **313 Description of Reclamation Plan**

The reclamation plan used to restore the vegetative, fish, and wildlife resources to a condition suitable for the post mining land use is presented in Section 340.

## **320 ENVIRONMENTAL DESCRIPTION**

### **321 Vegetation Information**

This section and the approved M&RP contain the environmental descriptions of the vegetation for the permit and adjacent areas.

Andalex Resources has been drilling "gob" gas vent holes as a safety requirement necessary to conduct their coal mining operations within the plateaus of the Book Cliffs mountain range. Because of the extreme urgency of the situation in early 2005, permitting of some emergency gas holes began in January 2005, with drilling proceeding soon afterwards. Initially, drill holes numbered GVH-01, GVH-02, GVH-03 were proposed for drilling (GVH-02 was later dropped from the plan). Following these drilling activities, additional drilling was necessary in the late-winter/early spring months the same year (sites: GVH-05 and GVH-06). Because it was necessary for the drilling to proceed during in the winter and spring months, or when quantitative assessment of the impacted plant communities was not possible, Andalex employed "Range Site" methods in the permitting process to drive the revegetation plan and provide final revegetation standards of success. More gas holes were necessary for venting requirements in the spring of 2005 beginning with GVH-04. Prior to disturbance by the drill rig, the plant communities to be impacted by

the drilling operations were quantitatively sampled including the proposed access road and drill pad. Additionally, a "Reference Area" with the same plant community was sampled. The Reference Area was used for comparisons of the proposed disturbed site at that time and will also be used at the time of final reclamation for standards of final revegetation success.

The next completed gob gas holes were numbered GVH-05A, GVH-07, GVH-08, and GVH-09. The plant communities that would be impacted by these drilling operations were quantitatively sampled in the growing season of 2005. Reference Areas were also chosen and sampled for these communities during the same time period. The following document was submitted to Andalex to report the results of the 2005 vegetation sampling period; and is included in Attachment 3-1 of this Appendix:

VEGETATION OF THE GAS VENT HOLES:  
GVH-04, GVH-05A, GVH-07, GVH-08,  
GVH-09 & REFERENCE AREAS  
2005

for the  
CENTENNIAL MINE

by  
MT. NEBO SCIENTIFIC, INC.

January 2006

Because the aforementioned emergency drill sites GVH-01, GVH-03, GVH-05 and GVH-06 were constructed in the winter and early spring months, or before vegetation sampling could be conducted, Reference Areas for them were chosen later in the growing season of 2005 when a better assessment of them could be made. These Reference Areas will be used later as standards for final revegetation success at these sites instead of using the Range Site method mentioned above. Based on a qualitative assessment of these sites, the **Sagebrush/Grass Reference Area** as reported in the above document will be used for the emergency, or first drill sites.

Three additional gob gas holes were approved in 2006 - GVH #5B, GVH #7A and GVH #8A. Required vegetation information for each of these sites is included in a report generated by Mt. Nebo Scientific which has been included in Attachment 3-1 - Vegetation Inventory - Approved Holes GVH-1 through GVH-9.

Note: GVH#5B will not be drilled and has been eliminated.

Fifteen additional gob gas holes are being proposed with this submittal - GVH#10, GVH#10A, GVH#11, GVH#11A, GVH#12, GVH#12A, GVH#13, GVH#13A, GVH#14, GVH#14A, GVH#15, GVH#15A, GVH#16, GVH#16A, and GVH#17.

Required vegetation information for the proposed sites is included in a new report generated by Mt. Nebo Scientific which is included as Attachment 3-5 - Vegetation Inventory - Proposed Holes GVH-10 through GVH-17. It should be noted that quantitative data were sampled and recorded for each of the proposed primary site locations GVH-10 through GVH-17, in the growing season of 2006. Appropriate reference areas were also chosen and sampled at that time. As with the soils, it was determined with the Division, that because of the vast amount of data and the consistency of the proposed site vegetation, additional sampling would not be required for each of the proposed alternate holes GVH-10A through GVH-16A. Instead, each of these holes will be evaluated separately based on available data for similar or adjacent sites.

The vegetation reports for Attachment 3-5 will consist of 2 separate reports. The main report will address all sampling and data collection for the primary proposed sites, GVH-10 through GVH-17. The second report will address the proposed alternate sites GVH-10A through GVH-16A, along with extrapolated data and conclusions for each of these sites.

The reports are entitled as follows:

VEGETATION OF THE GAS VENT HOLES:  
GVH-10, GVH-11, GVH-12, GVH-13, GVH-14, GVH-15, GVH-16, GVH-17, &  
REFERENCE AREAS  
2006  
FOR THE  
CENTENNIAL MINE

VEGETATION DESCRIPTIONS OF THE INTERMEDIATE GAS VENT HOLES:  
GVH-10 through GVH-17  
2006  
FOR THE  
CENTENNIAL MINE

### **321.100 Plant Communities Within the Proposed Permit Area**

Plate 19A of the M&RP shows the sites to be generally in the sagebrush-grass, aspen and oak brush communities. Vegetation specific to each of the sites is provided in this Appendix. A qualitative vegetative inventory (analysis) was completed during the summers of 2005 and 2006. (See Attachment 3-1 and 3-5)



Also, ARI has taken photographs of the proposed sites prior to disturbance. These photo locations are identifiable and repeatable. Although the photo locations were not staked, landmarks in the photos provide for identification as well as direction and location. The photos are included in Attachment 3-4.

### **321.200 Land Productivity Prior to Mining**

Land productivity prior to drilling has been estimated at approximately 1800 pounds per acre, based on range sites of High Mountain Loam. This productivity is assumed for all completed holes GVH-1 through GVH-9, as well as for all proposed holes GVH-10 through GVH-17.

## **322 Fish and Wildlife Information**

Fish and wildlife information associated with the degas wells is provided in this chapter. A summary of the fish and wildlife resource information for the permit and adjacent areas is contained in Section 322.100 through 322.200 of the approved M&RP.

### **322.100 Level of Detail**

The scope and level of detail within the "Gob Gas Vent Holes" amendment are sufficient to design the protection and enhancement plan for wildlife and fish associated with the degas wells. Additional information pertaining to fish and wildlife in the permit area is located in the M&RP.

### **322.200 Site-Specific Resource Information**

**Raptors** - An aerial raptor nest survey was done of the area by the Utah Division of Wildlife Resource personnel in 2004. The results of the survey are provided in Appendix D of the M&RP. Additional surveys have been done in 2005 and 2006, and are included with this submittal in the Confidential Binder for the Centennial Project.

A raptor survey will be conducted of the well site areas, each year that the wells are in operation.

**Bats** - No known open mine shafts, caves, adits or other man made structures that might provide habitats for bats are known to exist in the degas project area. The sites are open and the lack of a food source would force the bats to seek habitat and nourishment elsewhere.

**Threatened and Endangered Plant and Wildlife Species** - There are no known federally or state listed threatened and endangered plant and wildlife species within the sites planned for degassification wells. This is based on research and analysis by Mt. Nebo Scientific of Springville, Utah and EIS of Helper Utah as well as on-site evaluation by UDOGM specialists. The Bureau of Land Management has also reviewed the access and drill sites and has stated that although this area represents important habitat for both Mule deer and Elk, it is not characterized as crucial or critical.

There are no known groundwater or surface water flows to the Colorado or Green Rivers with potential for impact by the drilling of the degas wells. Potential adverse affects to the four Colorado River endangered fish species (refer to Table 3-2) would not be likely since there is no direct route to the Colorado River or Green River from the proposed well locations. Per the Windy Gap Process consumption estimates for the degas wells are as follows: Drilling - approximately 100,000 gallons per hole; road watering - approximately 5,000 gallons per day for 70 days per year; evaporation from ventilation - zero, drill holes will not intersect the coal seam being mined, therefore no access to mine ventilation until after area is sealed; coal preparation - zero, no coal preparation at degas sites (see Sections 522 and 523); sediment pond evaporation - zero, no sediment pond at degas sites (see Section 732.200); subsidence effects on springs - zero, no anticipated subsidence at degas sites (see Section 525); alluvial aquifer abstraction into mines - zero, no alluvial aquifer abstractions associated with degas drill holes (see Sections 513.500 and 600); postmining inflow to workings - zero, no workings for postmining inflow associated with degas wells (see Sections 513.500 and 600); coal moisture loss - zero, no coal therefore no moisture loss (See Sections 522 and 523). The overall impact of the mining operations, (including the degas holes) is shown on Table 3-2. Based on these calculations, the mining operation has a net positive impact to the Colorado River Drainage by the addition of 45.001 ac.ft./year.

**Table 3-1**  
**Federal and State Listed, Threatened, Endangered and Candidate Species**  
**Plants and Wildlife**  
**Carbon County, Utah**  
**October, 2002**

**CARBON**

Graham Beardtongue	<i>Penstemon grahamii</i>
Uinta Basin Hookless Cactus	<i>Schlerocactus glaucus</i>
Bonytail <sup>4, 10</sup>	<i>Gila elagans</i>
	E
Colorado Pikeminnow <sup>4, 10</sup>	<i>Ptychocheilus lucius</i>
Humpback Chub <sup>4, 10</sup>	<i>Gila cypha</i>
E	
Razorback Sucker <sup>4, 10</sup>	<i>Xyrauchen texanus</i>
E	
Bald Eagle <sup>3</sup>	<i>Haliaeetus leucocephalus</i>
T	
Mexican Spotted Owl <sup>4</sup>	<i>Strix occidentalis lucida</i>
T	
Western Yellow-billed Cuckoo	<i>Coccyzus americanus occidentalis</i>
Black-footed Ferret <sup>6</sup>	<i>Mustela nigripes</i>
E	

- 1 Nests in this county of Utah
- 2 Migrates through Utah, no resident populations.
- 3 Wintering populations (only five known nesting pairs in Utah).
- 4 Critical habitat designated in this county.
- 5 Critical habitat proposed in this county
- 6 Historical range.
- 7 Experimental nonessential population
- 8 Introduced, refugia population.
- 9 Candidate species have no legal population under the Endangered Species Act. However, these species are under active consideration by the Service for addition to the Federal List of Endangered and Threatened Species and may be proposed or listed during the development of the proposed project.
- 10 Water depletions from any portion of the occupied drainage basin are considered to adversely affect or adversely modify the critical habitat of the endangered fish species, and must be evaluated with regard to the criteria described in the pertinent fish recovery programs.

For additional information contact: U.S. Fish and Wildlife Service, Utah Field Office, 2369 West Orton Circle, Suite 50, West Valley City, Utah 84119 Telephone (801) 975-3330.

**Table 3-2**  
**Potential Water Depletion**  
**to**  
**Colorado River Drainage**

The following calculations are intended to define the potential depletion or addition of water to the Colorado River Drainage System, as a result of mining at this operation. It should be noted that the criteria is based on the U.S. Fish and Wildlife Service Windy Gap Process, and only those parameters that apply to this operation have been calculated.

**Projected Water Depletion**

- 1- Bathhouse/Office  
a. 140 people @ 35 gpd/ea x 240 days/yr = 1,176,000 gal/yr
- 2- Ventilation  
a. Evaporation
  - 1) 450,000 cfm = 236,520 M cf/yr
  - 2) 2.5 gallon/M cf = 591,300 gal/yr
- 3- Drilling GVH Wells  
a. 5 holes/yr @ 100,000 gal/hole = 500,000 gal/yr
- 4- Road Watering (GVH Sites)  
a. 5,000 gpd x 70 days/yr = 350,000 gal/yr

Total Loss =       2,617,300 gal/yr  
                              8.033 ac ft/yr

**Projected Water Addition**

- 1- Mine Discharge  
a. 100 gpm x 120 days/yr = 17,280,000 gal/yr

Total Gain =       17,280,000 gal/yr  
                              53.034 ac ft/yr

**Summary**

Projected Depletion =                               -8.033 ac ft/yr  
Projected Addition =                               +53.034 ac ft/yr

Total Addition =    +45.001 ac ft/yr

Note: Moisture loss from mined coal and use of sprays have not been included, since the spray water is derived from perched aquifers and is recycled within the mine. Any excess water from the perched aquifers is eventually discharged, resulting in the addition to streamflow.

### **322.300 Fish and Wildlife Service Review**

If requested, Andalex Resources, Inc. authorizes the release of information pertaining to Section 322 and 333 to the U.S. Fish And Wildlife Service Regional and Field Office for their review.

### **323 Maps and Aerial Photographs**

Location of the well sites can be seen in Figure 1-1 of this submittal.

#### **323.100 Location and Boundary of Proposed Reference Area**

Reference areas for all well sites have been established as described in Section 321. Subsequent holes will also use standard reference areas including baseline data.

#### **323.200 Elevation and Locations of Monitoring Stations**

N/A

#### **323.300 Facilities for Protection and Enhancement**

Section 333.300 and 358.500 of the approved M&RP contain additional discussion pertaining to protective measures to be taken by Andalex Resources, Inc.

#### **323.400 Vegetation Type and Plant Communities**

Vegetative types and plant communities are outlined in the vegetative reports in Attachments 3-1 and 3-5.

### **330 OPERATION PLAN**

#### **331 Measures Taken to Disturb the Smallest Possible Area**

The well sites will be sized to disturb the smallest acreage possible and still meet the requirements for the drilling equipment. The drainage control required will be built to satisfy the environmental requirements. Please refer to the typical proposed site plans for the gob gas wells which show estimated dimensions, location and type of sediment control, location of topsoil storage as well as approximate size and set-up of equipment.

#### **332 Description of Anticipated Impacts of Subsidence**

Refer to Section 525.

### **333 Plan to Minimize Disturbances and Adverse Impacts**

General control and mitigation measures addressing potential related biological impacts will include the following:

- Well sites will be fenced per landowner requirements and suitable for wildlife protection.
- Minimizing the total area of disturbance.
- Yearly raptor surveys during operations.
- Utilizing existing roads where possible.
- Water used for drilling and dust suppression is pumped from mine.
- Providing erosion protection and dust control as needed on roads.
- Design, construction and operation of well sites to minimize adverse impacts.
- Coordination and planning with the interdisciplinary wildlife team.
- Reclamation of disturbed areas when no longer needed.

#### **333.100 Minimize Disturbance to Endangered or Threatened Species**

Andalex Resources, Inc. will apply all methods necessary to minimize disturbances or any adverse effects to threatened or endangered species. Note that T&E species are not anticipated to be discovered, however, should ARI determine that such species exist, the regulatory authority will be notified and appropriate remedial action taken. Also, See Section 322.200.

#### **333.200 Species and Habitats**

All species and habitats within the permit area will be protected to the best of Andalex Resources, Inc. ability. Note that T&E species are not anticipated to be discovered, however, should ARI determine that such species exist, the regulatory authority will be notified and appropriate remedial action taken.

#### **333.300 Protective Measures**

Refer to Section 333.300 of the approved M&RP, and Section 333 above. All well sites will be fenced and road construction will be minimized by utilizing existing roads where possible.

### **340 RECLAMATION PLAN**

#### **341 Revegetation**

Revegetation of the sites will occur in two phases. The first phase is to redistribute topsoil and seed the well area not needed for access and operation of the gas exhaust blower. The second phase will consist of plugging the well and distributing the remaining topsoil and seeding on the remaining pad area. Refer to Section 242.100 for additional detail.



The second phase will consist of plugging the well and distributing the remaining topsoil and seeding on the remaining pad area. Refer to Section 242.100 for additional detail.

The short-term goal of this revegetation plan is the immediate stabilization of the disturbed sites through erosion control this objective will be achieved through controlled grading practices, proper seedbed preparation to encourage rapid plant establishment, inclusion of rapidly establishing species in the seed mixture to be planted, and mulch application.

The long-term goals are to establish useful, and productive range. These goals will be attained through the selection and placement of desirable and productive plant species and a commitment to monitor and maintain revegetated areas throughout the bond liability period.

The well sites will be fenced to discourage wildlife and livestock from grazing the reclaimed areas until bond release.

### **341.100 Schedule and Timetable**

The reclamation timetable shown in Figures 5-6 of this submittal and the reclamation monitoring schedule is found in Chapter 2, R645-301-240 of the approved M&RP.

### **341.200 Descriptions**

**Species and Amounts of Seed** - The well sites will be planted with the seed mix listed on Table 3-3. The seed mix will be used in both contemporaneous and final reclamation phases. The seed will be incorporated with a small amount of wood fiber mulch and applied by hydroseeding equipment or broadcast. Refer to Section 234.200 for topsoil stockpile seeding description.

**Methods Used for Planting and Seeding** - The degassification sites will be graded to final contour, then ripped to relieve compaction. The depth of ripping will be from 18 to 24 inches. Following ripping, topsoil will be applied to the ripped surface and left in a gouged and roughened state.

**Mulching Techniques** - Wood fiber mulch will be applied on top of the seed with hydroseeding equipment at the rate of 2,000 pounds per acre and anchored with a tackifier.

**Irrigation, Pest, and Disease Control** - No irrigation is planned and pesticides will not be used unless previously approved by the Division.

**Measures Proposed for Revegetation Success** - Refer to Section 356.

## **341.300 Greenhouse Studies, Field Trials, or Other Equivalent Studies**

Refer to the Section 341.300 of the approved M&RP.

### **342 Fish and Wildlife**

#### **342.100 Enhancement Measures**

Post bond release enhancement measures will include the establishment of vegetation for wildlife food, cover, and the break up of large blocks of monoculture to diversify habitat.

#### **342.200 Plants Used for Wildlife Habitat**

**Nutritional Value** - The nutritional value will be consistent with that of vegetation in the surrounding areas.

**Cover** - Cover will be comparable to the cover on the associated reference area.

#### **342.300 Cropland**

Cropland is not a postmining land use.

#### **342.400 Residential, Public Service, and Industrial Land Use**

No residential, industrial or public service use is planned.

### **350 PERFORMANCE STANDARDS**

#### **351 General Requirements**

Andalex Resources, Inc. commits to conduct all operations in accordance with the plans submitted in Sections R645-301-330 through R645-301-340 of the permit application.

#### **352 Contemporaneous Reclamation**

Reclamation activities prior to final reclamation will, to the extent feasible, be performed contemporaneously. Contemporaneous reclamation will be performed at the well sites following construction of the wells. Refer to Section 341 for additional details.

#### **353 Revegetation: General Requirements**

A vegetative cover will be established on all reclaimed areas to allow for the designated postmining land use of grazing. Refer to Section 411 for additional information.

### **353.100 Vegetative Cover**

The seed mix proposed for revegetation is intended to provide vegetative cover that will be diverse, effective, and permanent. The seed mixture was selected with respect to the climate, potential seedbed quality, erosion control, drought tolerance, and the mixture's ability for quick establishment and spreading.

**Native Species** - The reclamation vegetation mixture will be comprised of species indigenous to the area and capable of achieving the postmining land use. Diversity of species should allow utilization of plants by wildlife and domestic livestock. The recommended seed mix is comprised of native species.

**Extent of Cover** - The vegetative cover will be at least equal in extent to the cover at the designated reference areas.

**Stabilizing** - The vegetative cover mixture is capable of stabilizing the soil surfaces from erosion.

### **353.200 Reestablished Plant Species**

**Compatible** - The reestablished plant species have been selected to ensure their compatibility with the approved postmining use.

**Seasonal Characteristics** - The revegetation plant species will have the same growing season as the adjacent areas.

**Self-Generation** - The reestablished plants are species capable of self-generation and plant succession.

**Compatibility** - The seed mix suggested for revegetation contains plants native to the area and compatible with the plant and animal species of the permit area.

**Federal and Utah Laws or Regulation** - The seed mix purchased to revegetate the degassification well sites will contain no poisonous or noxious plants (see Section 234.200). No species will be introduced in the area without being approved by the Division.

**Table 3-3**  
**Reclamation Seed Mix**

The final reclamation seed mixture from the Centennial MRP will also be used for all interim, contemporaneous reclamation on the Gob Gas project sites and road slopes:

<u>SPECIES</u>	<u># PLS/acre</u>
<u>Grasses:</u>	
<u>Leymus cinereus</u>	2.0
Great Basin Wildrye	
<u>Agropyron spicatum</u>	2.0
Bluebunch Wheatgrass	
<u>Agropyron trachycaulum</u>	2.0
Slender Wheatgrass	
<u>Bromus inermis</u>	3.0
Smooth Brome	
<u>Oryzopsis hymenoides</u>	2.0
Indian Ricegrass	
<u>Poa sandbergii (secunda)</u>	0.25
Sandberg Bluegrass	
<u>Forbs:</u>	
<u>Artemisia ludoviciana</u>	0.1
Louisiana Sagebrush	
<u>Hedysarum borealis</u>	1.0
Northern Sweetvetch	
<u>Linum lewisii</u>	1.0
Lewis Flax	
<u>Penstemon strictus</u>	0.25
"Bandera" Rocky Mountain Penstemon	
<u>Shrubs:</u>	
<u>Amelanchier alnifolia</u>	1.0
Serviceberry	
<u>Artemisia tridentata vaseyana</u>	0.2
Mountain Big Sagebrush	
<u>Cercocarpus montanus</u>	1.0
True Mountain Mahogany	
<u>Cercocarpus ledifolius</u>	1.0
Curlleaf Mountain Mahogany	
<u>Chrysothamnus nauseosus albicaulis</u>	1.0
Whitestem Rubber Rabbitbrush	
<u>Purshia tridentata</u>	3.0
Bitterbrush	
<u>Symphoricarpos oreophilus</u>	1.0
Mountain Snowberry	
<b>Total</b>	<b>21.8</b>

Rate is pounds Pure Live Seed per acre for drill seeding. Broadcast seeding is double the drill rate.

### **353.300 Vegetative Exception**

Andalex Resources, Inc. does not require vegetative exception at this time.

### **353.400 Cropland**

The permit area contains no land designated as cropland.

### **354 Revegetation: Timing**

Andalex Resources, Inc. will follow the recommended guidelines for revegetation and planting during the first normal period for favorable planting conditions after replacement of the topsoil. In Utah the planting period is usually Fall due to the precipitation events.

### **355 Revegetation: Mulching and Other Soil Stabilizing Practices**

Mulch and/or other soil stabilizing practices (roughing, etc.) Will be used on all areas that have been regraded and covered by topsoil (Section 341.200). Andalex, Resources, Inc. will exercise care to guard against erosion during and after application of topsoil.

### **356 Revegetation: Standards for Success**

#### **356.100 Success of Revegetation**

The success of revegetation will be judged on the effectiveness of the vegetation for postmining land use, the extent of cover on each degassification well site compared to their respective reference areas as described in Section 321 and in Attachment 3-1.

**Sampling Techniques** - Andalex Resources, Inc. will comply with the standards for success, statistically valid sampling techniques for measuring success, and the approved methods outline in the Division's "Vegetation Information Guidelines, Appendix A" for sampling.

The sampling methods to be used during reclamation will be specific to the requirements at the time of reclamation. Nonetheless, according to the currently approved UDOGM guidelines, these sampling methods would be used: sample adequacy, cover (line interception), density (belt transects or plots) and productivity (clipping). The Jaccard's Community Coefficient will be used to calculate acceptable plant similarity and diversity.

**Standards for Success** - The standards for success will include criteria representative of undisturbed lands in the area of the degas wells as means to evaluate ground cover, production and stocking of the reclaimed site.

### **356.200 Standards for Success**

Standards of success will be applied in accordance with the approved postmining land use as described in this section.

**Grazing Land and Pasture Land** - The ground cover and production of living plants on the revegetated area will be at least equal to the reference area.

**Cropland** - There is no area designated as cropland within the degassification well sites.

**Fish and Wildlife Habitat** - The postmining land use for the degas well sites will be wildlife habitat on pre-existing roads. Pre-existing roads will be returned to their approximate original contour and compacted.

**Industrial, Commercial or Residential** - The postmining land use for the permit area is not designated for industrial, commercial, or residential use.

**Previously Disturbed Areas** - N/A

### **356.300 Siltation Structures**

Siltation structures will be maintained until the disturbed areas have been stabilized and revegetated. For additional details on siltation structures, see Sections 542 and 763 of this amendment.

### **356.400 Removal of Siltation Structures**

The land on which siltation structures are located will be revegetated in accordance with the reclamation plan discussed in Section 353 and 357. Refer to Section 763 for additional information pertaining to the removal of siltation structures.

### **357 Revegetation: Extended Responsibility Period**

Andalex Resources, Inc. will be responsible for the success of revegetation for a period of 10 years following seeding of the reclaimed area or upon Diviison bond release.

#### **357.100 Extended Period Begins**

The period of extended responsibility will begin after disturbed areas have been reseeded.

#### **357.200 Vegetation Parameters**

Vegetation parameters will equal or exceed the approved success standard during the last 2 years of the responsibility period. The success standards are outlined in Section 356 of this application.



### **357.300 Husbandry Practices**

The use of husbandry practices are not being requested.

### **358 Protection of Fish, Wildlife, and Related Environmental Values**

Andalex Resources, Inc. will minimize disturbances and adverse impacts on wildlife and their related environments as outlined in Section 333 of the approved M&RP and Section 342 of this submittal. See Chapter 7, Section 731.100 of the approved M&RP for methods to protect water sources in the area.

#### **358.100 Existence of Endangered or Threatened Species**

The well sites will not be constructed or operated where they might jeopardize the existence of any endangered or threatened species. Refer to Section 322.200 and Attachments 3-1, 3-2 and 3-3 for additional information pertaining to threatened, endangered, and sensitive species.

State or federally listed endangered or threatened species will be reported to the Division upon its discovery.

#### **358.200 Bald and Golden Eagles**

Andalex Resources, Inc. understands that there is no permission implied by these regulations for taking of bald or golden eagles, their nest, or eggs. If found, nests will be reported to the Division.

#### **358.300 Taking of Endangered or Threatened Species**

Andalex Resources, Inc. understands that there is no permission implied by these regulations for taking of endangered or threatened species, their nest, or eggs.

#### **358.400 Replacement of Wetland or Riparian Vegetation**

The sites contain no wetland or riparian vegetation.

#### **358.500 Manmade Wildlife Protection Measure**

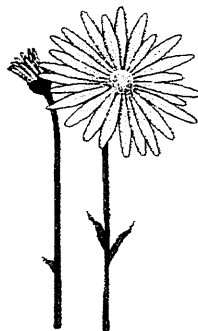
**Electric Power Lines** - No utilities will exist at the well sites.

**Potential Barriers** - No potential barriers will exist at any of the well sites. No ponds exist at the well sites. Refer to Section 231.100 and 242 for information pertaining to the mud pit.

**ATTACHMENT 3-1  
VEGETATION INVENTORY  
APPROVED HOLES GVH-1 through GVH-9**

**VEGETATION OF THE GAS VENT HOLES:  
GVH-04, GVH-05A, GVH-07, GVH-08,  
GVH-09 & REFERENCE AREAS  
2005**

**FOR THE  
CENTENNIAL MINE**



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## TABLE OF CONTENTS

INTRODUCTION .....	1
METHODS .....	1
Sampling Design and Transect/Quadrat Placement .....	2
Cover and Composition .....	3
Woody Species Density .....	3
Sample Size & Adequacy .....	4
Statistical Analyses .....	4
Photographs .....	4
Threatened & Endangered Plant Species .....	5
Raw Data .....	5
RESULTS .....	5
GVH-04 .....	5
GVH-05A .....	6
GVH-07 .....	7
GVH-08 .....	7
GVH-09 .....	8
Sagebrush/Grass Reference Area .....	9
Aspen/Grass Reference Area .....	10
Threatened & Endangered Plant Species Survey .....	10
DISCUSSION .....	11
DATA SUMMARY TABLES .....	14-20
FIGURES .....	21-22
MAP OF VEGETATION SAMPLE AREAS .....	23
COLOR PHOTOGRAPHS .....	24-27
RAW DATA SET .....	Appendix

## INTRODUCTION

Andalex Resources has proposed to drill a number of boreholes at strategic locations to vent “gob” gas as a safety procedure prior to mining the areas beneath them. The drilling activities will necessitate disturbing about one acre of the vegetation at each drill site. The purpose of this document is to summarize the findings of quantitative sampling the plant communities proposed for disturbance along with “reference areas” chosen for future revegetation success standards. The vegetation data of the reference areas may be compared to the data of the reseeded drill sites now, as well as in the future when the boreholes have fulfilled their purpose and the drill sites are reclaimed. A sensitive species survey was also conducted on each site during the growing season of 2005.

## METHODS

Methodologies used for this study were performed in accordance with the guidelines supplied by the State of Utah, Division of Oil, Gas and Mining (DOGM). Quantitative and qualitative data were taken on the vegetation of the areas proposed for disturbance and their respective reference areas between June 16 and September 20, 2005.



Proposed drill sites were surveyed, mapped and staked in the field by Andalex Resources prior to the field work performed for the vegetation surveys. The reference areas chosen were approximately one-acre in size and were marked in the field using a GPS instrument. The coordinates for the proposed GVH drill pads and reference areas are given below. A map showing these locations has been included in this report (see 2005 Vegetation Sample Areas).

GPS COORDINATES FOR CENTENNIAL MINE VEGETATION SAMPLE SITES					
Site Name	Waypoint Name	Zone	Easting	Northing	Notes
GVH-04	ANGVH4	12S	0521726	4397745	
GVH-05A	ANGV5B	12S	0523291	4398220	Original site number was changed and adjusted for this report.
GVH-07	AGVH08	12S	0522386	4398208	Original site number was changed and adjusted for this report.
GVH-08	AGVH09	12S	0521952	4398209	Original site number was changed and adjusted for this report.
GVH-09	AGVH10	12S	0521533	4398202	Original site number was changed and adjusted for this report.
Reference Area (GVH-04, GVH-05A, GVH-07, GVH-09)	AGVH4R	12S	0521661	4397608	
Reference Area (GVH-08)	AGVH9R	12S	0522002	4398050	Original site number was changed and adjusted for this report.

#### Sampling Design and Transect/Quadrat Placement

Transect lines for vegetation sampling were placed randomly within the boundaries of the

proposed disturbed and reference areas. The sample boundaries included 100 ft outside the proposed drill sites. The transect placement technique was employed with the goal to adequately sample a representative subset of the entire site as a whole. Once the transects were established, quadrat locations for sampling were chosen using random numbers from the transect lines with the objective to record data without preconceived bias.

### Cover and Composition

Cover estimates were made using ocular methods with meter square quadrats. Species composition, cover by species, and relative frequencies were also assessed from the quadrats. Additional information recorded on the raw data sheets were: estimated precipitation, slope, exposure, grazing use, animal disturbance and other appropriate notes. Plant nomenclature follows "A Utah Flora" (Welsh et al., 2003).

### Woody Species Density

Density of woody plant species for the proposed disturbed and reference areas were estimated using the point-quarter method. In this method, random points were placed on the sample sites and measured into four quarters. The distances to the nearest woody plant species were then recorded in each quarter. The average point-to-individual distance was equal to the square root of the mean area per individual. The number of individuals per acre was the end results of the calculations.

## Sample Size & Adequacy

Sampling adequacy for cover and density was attempted by using the formula given below.

$$n_{MIN} = \frac{t^2 s^2}{(dx)^2}$$

where,

$n_{MIN}$	= minimum adequate sample
$t$	= appropriate confidence t-value
$s$	= standard deviation
$\bar{x}$	= sample mean
$d$	= desired change from mean

With the values used for “t” and “d” above, the goal was to meet sample adequacy with 80% confidence within a 10% deviation from the true mean.

## Statistical Analyses

Student's t-tests were employed to compare the total living cover and total woody species density of each proposed disturbed borehole site with its respective reference area.

## Photographs

Color photographs of the sample areas were taken at the time of sampling and have been submitted with this report.

### Threatened & Endangered Plant Species

Prior to recording quantitative data on the plant communities, a sensitive plant species survey was conducted. To initiate the study, appropriate agencies were consulted and other sources were reviewed (sensitive species files at *Mt. Nebo Scientific, Inc.*) for potential plant species that are known to be rare, endemic, threatened, endangered or otherwise sensitive in the study area.

### Raw Data

The raw data for cover have been summarized on a spreadsheet and were included in the Appendix of this report.

## RESULTS

Below are the results from sampling each vegetation study site for this report. Locations of these sites are shown on the Vegetation Sample Areas map. Color photographs of each sample site have also been provided later in this document.

### GVH-04

Because of the necessity to also create an access road to this drill site, the plant communities associated with both the proposed drill pad and new road were sampled. Since the communities

were the same for each disturbance type here, the data were combined summarized to create a larger data set.

Table 1 shows the percent cover of each of the plant species encountered in the sample quadrats at the GVH-04 site. The dominant plant species in this area were big sagebrush (*Artemisia tridentata*), viscid rabbitbrush (*Chrysothamnus viscidiflorus*) and Salina wildrye (*Elymus salinus*).

The total living cover for this sagebrush/grass community was estimated at 58.13% (Table 2-A). Shrubs dominated the composition comprising 50.69% of the total living cover, followed by forbs and grasses at 31.79% and 17.52%, respectively (Table 2-B). Woody species density in this community was 12,787 individuals per acre (Table 3) and was dominated by the same woody species prevalent in the cover measurements described above.

#### GVH-05A

Drill pad GVH-05A was located in the general vicinity of an earlier constructed drill pad called GVH-05. The location of GVH-05A was shifted slightly to the west of where it was originally marked in the field, but the change did not affect the plant community type to be impacted by the proposed disturbance – the sagebrush/grass type.

The dominant plant species of this site were big sagebrush, Kentucky bluegrass (*Poa pratensis*), and viscid rabbitbrush (Table 4). The total living cover of the site was 59.75% (Table 5-A).

Shrubs dominated the composition constituting 49.91% of the total living cover, followed by grasses at 34.25% and forbs at 15.84% (Table 5-B). The woody species density for GVH-05A was estimated at 5,786 individuals per acre and was comprised of big sagebrush, snowberry (*Symphoricarpos oreophilus*), and viscid rabbitbrush (Table 6).

#### GVH-07

This proposed drill site supported another sagebrush/grass plant community. The dominant plant species in the cover data as shown on Table 7 were big sagebrush, viscid rabbitbrush, Kentucky bluegrass and bluebunch wheatgrass (*Elymus spicatus*). The total living cover of GVH-07 was estimated at 60.25% (Table 8-A). Shrubs again dominated the composition of this site where they represented 57.58% of the total living cover, followed by grasses at 34.41% and forbs at 8.00% (Table 8-B). The woody species density of this site was estimated at 6,944 plants per acre with the same three species as mentioned in the previous sites represented in this measurement – big sagebrush, viscid rabbitbrush and snowberry (Table 9).

#### GVH-08

The proposed drill pad of this site supported an aspen/grass plant community type. The plants in this area seemed to have been affected by some environmental stress conditions such as the recent droughts of Utah, possibly in conjunction with grazing pressures. Many of the aspen trees (*Populus tremuloides*) showed stress with some of the older trees dead or dying, but there seemed



to be rejuvenation occurring by saplings present in these clonal communities probably due to the recent increase in the precipitation patterns of the area.

The most common overstory species by cover and frequency was aspen; understory dominants were snowberry and Kentucky bluegrass (Table 10). The living cover was comprised of 13.75% overstory and 56.50% understory, or a total combined living cover of 70.25% (Table 11-A). The cover composition breakdown consisted of 43.96% trees/shrubs, 32.91% grasses, and 23.13% forbs (Table 11-B). Total woody species density was 2,646 plants per acre and was dominated by snowberry and aspen (Table 12).

#### GVH-09

Once again, the proposed drill site here was located within a sagebrush/grass plant community, however, this one had been previously impacted by a dirt road and was also the possible site of an old sheep camp or salt-lick area for cattle. In other words, the plant community was not that of a native, pristine community, so along with native species, it also supported several “weedy” species such as dandelion (*Taraxacum officinale*), hound’s tongue (*Cynoglossum officinale*) and knotweed (*Polygonum aviculare*). The dominant species by cover and frequency were sagebrush, Aster (*Aster* sp.) yarrow (*Achillea millefolium*) and dandelion (Table 13).

Total living cover of this area was 54.00% (Table 14-A). Due to impacts previously mentioned, the cover composition consisted of more forbs (42.78%) than the other sagebrush/grass

communities described in this report. Shrubs comprised 35.06% of the total living cover, whereas, grasses 22.16% (Table 14-B). Total woody species density of the site was 3,678 individuals per acre and, much like the above sagebrush/grass communities, consisted of big sagebrush, viscid rabbitbrush, and snowberry (Table 18).

#### Sagebrush/Grass Reference Area

A native, undisturbed sagebrush/grass plant community was chosen to represent future revegetation success standards for those sites that had been proposed for disturbance and also supported this same community type (GVH-04, GVH-05A, GVH-07, GVH-09). Even though this reference area was a sagebrush/grass plant community and similar to the other communities sampled, the species composition of each of the proposed disturbed sagebrush/grass communities described in this report varied somewhat. Still, this site could be an appropriate reference area for the proposed disturbed sagebrush/grass communities at the time of final revegetation (more about this in the DISCUSSION section of this report).

The dominant plant species of this reference area by cover and frequency were big sagebrush, viscid rabbitbrush, larkspur (*Delphinium nelsonii*), Watson's penstemon (*Penstemon watsonii*), and Salina wildrye (Table 16). The total living cover for the sagebrush/grass reference area was estimated at 62.25% (Table 17-A). Within this total living cover measurement, 52.13% of it were from shrubs, 34.58% were forbs, and 13.29% were grasses (Table 17-B). Woody species density was estimated at 13,025 individuals per acre and was dominated by viscid rabbitbrush, big sagebrush, and snowberry (Table 18).

### Aspen/Grass Reference Area

The aspen/grass reference area chosen for future standards was located in the vicinity of the proposed disturbed aspen/grass community, or GVH-08 (see Vegetation Sample map). This community had an overstory cover of aspens at 24.25% (Tables 19 & 20-A). Dominant understory species were snowberry, lupine (*Lupinus argenteus*), Kentucky bluegrass, and aspen (Table 19). The total living understory cover in this community was 52.00%, while the total combined overstory and understory cover was 76.25% (Table 20-A). Trees and shrubs dominated the cover composition at 58.95%, whereas forbs and grasses were nearly equally represented at 20.79% and 20.26%, respectively (Table 20-B). The total woody species density was estimated at 3,702 individuals per acre and was dominated by snowberry, broom snakeweed (*Gutierrezia sarothrae*) and aspen (Table 21).

### Threatened & Endangered Plant Species Survey

Each proposed disturbed area was surveyed in the field for canyon vetch (or any other threatened, endangered, unusual, rare or sensitive plants). This survey was done prior to recording the quantitative data used to describe the major plant communities of the study areas. In addition, more searching for sensitive species was done during quantitative sampling of the areas.

State databases revealed only one potential sensitive species to be located in the vicinity of the

proposed disturbed borehole sites. This plant was canyon vetch (*Hedysarum occidentale* var. *canone*). No rare, endemic, threatened or endangered or otherwise sensitive species were found in the study areas.

## DISCUSSION

Statistical analyses were employed to compare the total living cover and density measurements of the proposed disturbed drill sites with their reference areas (Fig. 1 and Fig. 2). Since many of the plant communities proposed for disturbance were generally a sagebrush/grass type, only one reference area for this type was chosen. There was another reference area chosen for revegetation success standards for the drill pad that would disturb an aspen/grass community (see Vegetation Sample Area map).

In all but one of the statistical analyses, when **total living cover** of the proposed disturbed area was compared with the reference area, the differences were not significant (Fig. 1). For GVH-09, however, the cover was significantly less than the sagebrush/grass reference area. Reasons for this difference was probably a consequence of the present condition of the vegetation at GVH-09. As explained in the RESULTS section above, this site had been previously disturbed. This fact may be considered at the time final reclamation, but there will probably not be a problem with achieving the standards set by using an undisturbed sagebrush/grass community as the reference area.

When **woody species densities** of each site were compared statistically the test results varied. For the proposed disturbed sagebrush/grass sites (GVH-04, GVH-05A, GVH-07, GVH-09), only the density value for GVH-04 was *not* significantly different than its reference area. In all other sagebrush/grass community types, the reference area had significantly greater densities than the proposed disturbed areas (Fig. 2). These and other differences were not apparent until later, when the field data were summarized in spreadsheets and statistical test could be employed. The one sagebrush/grass site where its density value was *not* significantly different when compared to the reference area was GVH-04, probably because of the very close proximity to each other. Because of this, environmental variables (exposure, soils, slope, elevation, grazing practices, etc.) of these two areas were nearly exactly the same.

Although similar with respect to dominant plant species and some of the aforementioned environmental variables, the other proposed disturbed sagebrush/grass sites occupied areas where some of these variables were slightly different. These dissimilarities may be the reason for the differences in total density and other data parameters such as species composition. Additionally, although species diversity indices were not required for comparisons at this phase of the permitting process, a cursory review of the data sets suggests that diversity of the reference area chosen for the proposed disturbed sagebrush/grass areas may be greater than the proposed disturbed areas.

The differences between the data of some to the proposed disturbed drill sites when compared with the reference area are mentioned here because the following question arises – *does the*

*reference area chosen for the sagebrush/grass community provide too stringent or unfair standards for future revegetation success for some sites?* If the answer to this question is yes, then the following actions could be considered by the mine operator and regulatory agency. First, the differences noted in the data sets at this time such as woody species density, species composition and species diversity could be taken into consideration at the time sampling is conducted for future final revegetation comparisons. If the reclaimed drill sites do not meet all the requirements of the current reference area, the success standards could then be adjusted proportionately (as calculated by the data sets in this document). Another possible solution would be to select additional sagebrush/grass reference areas for GVH-05, GVH-07 and GVH-09. This could be done soon (i.e. the growing season of 2006), or later (closer to when final revegetation work is planned). Finally, based on the data herein, specific success standards could be dictated at this time that would be used for final revegetation success standards. For example, one could set a standard for woody species density at some specific value such as 2,500 plants per acre for the reclaimed sagebrush/grass sites. Species diversity values could also be set using the data sets reported in this document with the stipulation that they be approved by the regulatory agency beforehand. These topics could be entertained following submittal and review of this report.

**Table 1: Centennial Mine. Total Living Cover and Frequency by Plant Species.**  
**Site: GVH-04 (Proposed Disturbed Sagebrush/Grass).**

	Mean Percent	Standard Deviation	Percent Frequency
<b>TREES &amp; SHRUBS</b>			
<i>Artemisia tridentata</i>	15.33	13.38	80.00
<i>Chrysothamnus viscidiflorus</i>	13.48	11.07	80.00
<i>Symphoricarpos oreophilus</i>	1.80	3.75	22.50
<b>FORBS</b>			
<i>Achillea millefolium</i>	0.68	2.00	12.50
<i>Astragalus sp.</i>	0.13	0.56	5.00
<i>Clematis hirsutissima</i>	0.05	0.31	2.50
<i>Collinsia parvifolia</i>	0.18	0.83	5.00
<i>Cymopterus longipes</i>	0.30	1.12	7.50
<i>Delphinium nelsonii</i>	6.93	3.96	85.00
<i>Erigeron engelmannii</i>	0.50	1.50	10.00
<i>Gilia leptomeria</i>	2.08	3.06	40.00
<i>Lupinus argenteus</i>	0.13	0.78	2.50
<i>Penstemon watsonii</i>	2.20	4.01	35.00
<i>Phlox longifolia</i>	0.88	1.90	17.50
<i>Potentilla concinna</i>	0.13	0.78	2.50
<i>Taraxacum officinale</i>	0.85	2.13	17.50
<i>Viola nuttallii</i>	2.85	2.96	55.00
<b>GRASSES</b>			
<i>Elymus salinus</i>	4.98	5.02	62.00
<i>Festuca ovina</i>	0.70	2.62	7.50
<i>Poa compressa</i>	0.13	0.78	2.50
<i>Poa secunda</i>	2.18	3.35	35.00
<i>Stipa columbiana</i>	1.70	3.42	25.00

**Table 2: Centennial Mine. Total Cover, Composition, and Sample Size.**  
**Site: GVH-04 (Proposed Disturbed Sagebrush/Grass).**

	Mean Percent	Standard Deviation	Sample Size
<b>A. TOTAL COVER</b>			
Understory	58.13	11.05	40
Litter	16.55	7.22	40
Bareground	23.10	12.57	40
Rock	2.23	5.35	40
<b>B. COMPOSITION</b>			
Shrubs	50.69	16.14	40
Forbs	31.79	13.16	40
Grasses	17.52	10.89	40

**Table 3: Centennial Mine. Woody Species Density.**  
**Site: GVH-04 (Proposed Disturbed Sagebrush/Grass).**

SPECIES	Individuals Per Acre
<i>Artemisia tridentata</i>	5114.81
<i>Chrysothamnus viscidiflorus</i>	7192.71
<i>Symphoricarpos oreophilus</i>	479.51
<b>TOTAL</b>	<b>12787.03</b>



**Table 4: Centennial Mine. Total Living Cover and Frequency by Plant Species.**  
**Site: GVH-05A (Proposed Disturbed Sagebrush/Grass).**

UNDERSTORY			
SHRUBS	Mean	SDev	Freq
<i>Artemisia tridentata</i>	18.75	13.68	90.00
<i>Chrysothamnus viscidiflorus</i>	9.50	11.61	50.00
<i>Symphoricarpos oreophilus</i>	2.25	4.32	25.00
FORBS			
<i>Aster sp.</i>	1.25	5.45	5.00
<i>Astragalus sp.</i>	0.50	1.50	10.00
<i>Cynoglossum officinale</i>	0.25	1.09	5.00
<i>Lupinus argenteus</i>	2.25	4.32	25.00
<i>Penstemon watsonii</i>	4.25	4.55	55.00
<i>Taraxacum officinale</i>	0.50	2.18	5.00
GRASSES			
<i>Elymus spicatus</i>	2.50	4.33	30.00
<i>Poa pratensis</i>	11.75	9.39	75.00
<i>Stipa columbiana</i>	6.00	9.82	30.00

**Table 5: Centennial Mine. Total Cover, Composition, and Sample Size.**  
**Site: GVH-05A (Proposed Disturbed Sagebrush/Grass).**

	Mean Percent	Standard Deviation	Sample Size
<b>A. TOTAL COVER</b>			
Understory	59.75	9.81	20
Litter	24.60	9.99	20
Bareground	14.45	9.17	20
Rock	1.20	0.40	20
<b>B. COMPOSITION</b>			
Shrubs	49.91	19.53	20
Forbs	15.84	13.04	20
Grasses	34.25	14.82	20

**Table 6: Centennial Mine. Woody Species Density.**  
**Site: GVH-05A (Proposed Disturbed Sagebrush/Grass).**

SPECIES	Individuals Per Acre
<i>Artemisia tridentata</i>	4050.15
<i>Chrysothamnus viscidiflorus</i>	1012.54
<i>Symphoricarpos oreophilus</i>	723.24
<b>TOTAL</b>	<b>5785.93</b>

**Table 7: Centennial Mine. Total Living Cover and Frequency by Plant Species.**  
**Site: GVH-07. (Proposed Disturbed Sagebrush/Grass).**

UNDERSTORY			
SHRUBS	Mean	SDev	Freq
<i>Artemisia tridentata</i>	18.00	13.91	85.00
<i>Chrysothamnus viscidiflorus</i>	16.50	9.10	90.00
<i>Symphoricarpos oreophilus</i>	0.25	1.09	5.00
FORBS			
<i>Antennaria dimorpha</i>	0.25	1.09	5.00
<i>Lupinus argenteus</i>	0.50	2.18	5.00
<i>Penstemon watsonii</i>	3.50	7.43	20.00
<i>Taraxacum officinale</i>	0.50	2.18	5.00
GRASSES			
<i>Elymus spicatus</i>	8.75	12.83	50.00
<i>Poa pratensis</i>	9.75	11.34	65.00
<i>Stipa columbiana</i>	2.25	4.32	25.00

**Table 8: Centennial Mine. Total Cover, Composition, and Sample Size.**  
**Site GVH-07 (Proposed Disturbed Sagebrush/Grass).**

	Mean Percent	Standard Deviation	Sample Size
<b>A. TOTAL COVER</b>			
Understory	60.25	10.30	20
Litter	18.75	9.93	20
Bareground	19.05	12.92	20
Rock	1.95	2.91	20
<b>B. COMPOSITION</b>			
Shrubs	57.58	17.97	20
Forbs	8.00	13.25	20
Grasses	34.41	16.27	20

**Table 9: Centennial Mine. Woody Species Density.**  
**Site: GVH-07 (Proposed Disturbed Sagebrush/Grass).**

SPECIES	Individuals Per Acre
<i>Artemisia tridentata</i>	3211.66
<i>Chrysothamnus viscidiflorus</i>	3472.07
<i>Symphoricarpos oreophilus</i>	260.41
<b>TOTAL</b>	<b>6944.14</b>

**Table 10: Centennial Mine. Total Living Cover and Frequency by Plant Species.**  
**Site: GVH-08 (Proposed Disturbed Aspen/Grass).**

OVERSTORY	Mean	SDev	Freq
<i>Populus tremuloides</i>	13.75	17.60	50.00
UNDERSTORY			
SHRUBS			
<i>Amelanchier utahensis</i>	0.25	1.09	5.00
<i>Artemisia tridentata</i>	1.50	4.50	15.00
<i>Chrysothamnus viscidiflorus</i>	1.65	3.77	20.00
<i>Populus tremuloides</i>	4.50	5.89	40.00
<i>Rosa woodsii</i>	0.25	1.09	5.00
<i>Symphoricarpos oreophilus</i>	16.50	20.74	60.00
FORBS			
<i>Achillea millefolium</i>	2.75	4.60	30.00
<i>Collomia linearis</i>	0.10	0.44	5.00
<i>Cynoglossum officinale</i>	0.75	1.79	15.00
<i>Lupinus argenteus</i>	3.50	5.02	40.00
<i>Potentilla concinna</i>	0.25	1.09	5.00
<i>Taraxacum officinale</i>	5.50	7.89	50.00
GRASSES			
<i>Elymus spicatus</i>	1.50	3.20	20.00
<i>Elymus trachycaulus</i>	0.50	2.18	5.00
<i>Poa pratensis</i>	15.25	17.28	50.00
<i>Stipa columbiana</i>	1.75	3.63	20.00

**Table 11: Centennial Mine. Total Cover, Composition, and Sample Size.**  
**Site: GVH-08 (Proposed Disturbed Aspen/Grass).**

	Mean Percent	Standard Deviation	Sample Size
<b>A. TOTAL COVER</b>			
Overstory (o)	13.75	17.60	
Understory (u)	56.50	13.24	20
Litter	23.20	10.82	20
Bareground	18.50	12.60	20
Rock	1.80	1.60	20
o + u	70.25	21.76	20
<b>B. COMPOSITION</b>			
Trees & Shrubs	43.96	32.54	20
Forbs	23.13	17.75	20
Grasses	32.91	25.35	20

**Table 12: Centennial Mine. Woody Species Density.**  
**Site: GVH-08 (Proposed Disturbed Sagebrush/Grass).**

SPECIES	Individuals Per Acre
<i>Amelanchier utahensis</i>	33.07
<i>Artemisia tridentata</i>	99.22
<i>Chrysothamnus viscidiflorus</i>	165.37
<i>Populus tremuloides</i>	826.86
<i>Rosa woodsii</i>	264.59
<i>Symphoricarpos oreophilus</i>	1256.82
<b>TOTAL</b>	<b>2645.84</b>

**Table 13: Centennial Mine. Total Living Cover and Frequency by Plant Species.**  
**Site: GVH-09. (Proposed Disturbed Sagebrush/Grass).**

UNDERSTORY	Mean	SDev	Freq
<b>SHRUBS</b>			
<i>Artemisia tridentata</i>	15.75	17.56	60.00
<i>Chrysothamnus viscidiflorus</i>	2.75	4.87	30.00
<i>Symphoricarpos oreophilus</i>	0.90	2.21	15.00
<b>FORBS</b>			
<i>Achillea millefolium</i>	4.75	6.42	45.00
<i>Aster sp.</i>	7.75	12.99	40.00
<i>Cirsium sp.</i>	0.25	1.09	5.00
<i>Cynoglossum officinale</i>	0.25	1.09	5.00
<i>Lupinus argenteus</i>	0.95	2.29	15.00
<i>Penstemon watsonii</i>	0.75	1.79	15.00
<i>Polygonum aviculare</i>	3.75	7.56	25.00
<i>Taraxacum officinale</i>	4.75	10.54	30.00
<b>GRASSES</b>			
<i>Elymus spicatus</i>	2.25	4.02	30.00
<i>Elymus trachycaulus</i>	0.75	3.27	5.00
<i>Poa pratensis</i>	8.15	9.51	50.00
<i>Poa secunda</i>	0.25	1.09	5.00

**Table 14: Centennial Mine. Total Cover, Composition, and Sample Size.**  
**Site: GVH-09 (Proposed Disturbed Sagebrush/Grass).**

	Mean Percent	Standard Deviation	Sample Size
<b>A. TOTAL COVER</b>			
Understory	54.00	11.25	20
Litter	18.30	9.19	20
Bareground	25.80	15.40	20
Rock	1.90	2.21	20
<b>B. COMPOSITION</b>			
Shrubs	35.06	28.26	20
Forbs	42.78	33.08	20
Grasses	22.16	18.65	20

**Table 15: Centennial Mine. Woody Species Density.**  
**Site: GVH-09 (Proposed Disturbed Sagebrush/Grass).**

SPECIES	Individuals Per Acre
<i>Artemisia tridentata</i>	2206.97
<i>Chrysothamnus viscidiflorus</i>	1195.44
<i>Symphoricarpos oreophilus</i>	275.87
<b>TOTAL</b>	<b>3678.28</b>

**Table 16: Centennial Mine. Total Living Cover and Frequency by Plant Species.**  
Reference Area: Sagebrush/Grass.

	Mean	SDev	Freq
<b>TREES &amp; SHRUBS</b>			
<i>Amelanchier utahensis</i>	0.13	0.78	2.50
<i>Artemisia tridentata</i>	19.28	15.27	90.00
<i>Chrysothamnus viscidiflorus</i>	11.20	11.14	70.00
<i>Symphoricarpos oreophilus</i>	2.68	4.28	32.50
<b>FORBS</b>			
<i>Achillea millefolium</i>	0.20	0.90	5.00
<i>Antennaria dimorpha</i>	0.13	0.78	2.50
<i>Arabis holboellii</i>	0.08	0.47	2.50
<i>Astragalus</i> sp.	0.13	0.56	5.00
<i>Collinsia parvifolia</i>	0.05	0.31	2.50
<i>Cymopterus longipes</i>	3.10	2.43	65.00
<i>Delphinium nelsonii</i>	5.93	5.08	70.00
<i>Erigeron engelmannii</i>	1.30	2.52	25.00
<i>Eriogonum</i> sp.	0.13	0.78	2.50
<i>Gilia leptomeria</i>	0.80	2.23	12.50
<i>Lupinus argenteus</i>	0.63	1.65	12.50
<i>Penstemon watsonii</i>	4.90	4.39	67.50
<i>Phlox longifolia</i>	1.03	2.17	22.50
<i>Potentilla concinna</i>	0.25	1.09	5.00
<i>Senecio multilobatus</i>	0.08	0.47	2.50
<i>Taraxacum officinale</i>	1.33	2.07	32.50
<i>Viola nuttallii</i>	0.83	1.82	17.50
<b>GRASSES</b>			
<i>Elymus salinus</i>	4.38	5.27	50.00
<i>Festuca ovina</i>	2.25	5.58	22.50
<i>Poa secunda</i>	0.88	2.47	12.50
<i>Stipa columbiana</i>	0.63	2.00	10.00

**Table 17: Centennial Mine. Total Cover, Composition, and Sample Size.**  
Reference Area: Sagebrush/Grass (GVH-04).

	Mean Percent	Standard Deviation	Sample Size
<b>A. TOTAL COVER</b>			
Understory	62.25	8.51	40
Litter	17.55	8.27	40
Bareground	16.30	11.66	40
Rock	3.90	5.30	40
<b>B. COMPOSITION</b>			
Shrubs	52.13	18.41	40
Forbs	34.58	15.32	40
Grasses	13.29	12.03	40

**Table 18: Centennial Mine. Woody Species Density.**  
Reference Area: Sagebrush/Grass.

SPECIES	Individuals Per Acre
<i>Amelanchier utahensis</i>	81.41
<i>Artemisia tridentata</i>	5535.70
<i>Chrysothamnus viscidiflorus</i>	6105.55
<i>Symphoricarpos oreophilus</i>	1302.52
<b>TOTAL</b>	<b>13025.18</b>

**Table 19: Centennial Mine. Total Living Cover and Frequency by Plant Species.**  
Reference Area: Aspen/Grass (GVH-08).

	Mean	SDev	Freq
<b>OVERSTORY</b>			
<i>Populus tremuloides</i>	24.25	17.77	75.00
<b>UNDERSTORY</b>			
<b>SHRUBS</b>			
<i>Artemisia tridentata</i>	1.25	3.49	15.00
<i>Chrysothamnus viscidiflorus</i>	6.00	10.07	35.00
<i>Populus tremuloides</i>	6.50	11.84	35.00
<i>Rosa woodsii</i>	4.75	11.01	25.00
<i>Symphoricarpos oreophilus</i>	12.75	17.06	50.00
<b>FORBS</b>			
<i>Achillea millefolium</i>	0.25	1.09	5.00
<i>Cynoglossum officinale</i>	0.25	1.09	5.00
<i>Lupinus argenteus</i>	9.25	6.76	85.00
<b>GRASSES</b>			
<i>Bromus carinatus</i>	0.50	2.18	5.00
<i>Elymus spicatus</i>	1.50	4.50	15.00
<i>Poa pratensis</i>	8.25	13.44	50.00
<i>Stipa columbiana</i>	0.75	1.79	15.00

**Table 20: Centennial Mine. Total Cover, Composition, and Sample Size.**  
Reference Area: Aspen/Grass (GVH-08).

	Mean Percent	Standard Deviation	Sample Size
<b>A. TOTAL COVER</b>			
Overstory (o)	24.25	17.77	20
Understory (u)	52.00	13.55	20
Litter	27.10	14.70	20
Bareground	19.65	18.42	20
Rock	1.25	0.89	20
o + u	76.25	18.43	20
<b>B. COMPOSITION</b>			
Trees & Shrubs	58.95	28.06	20
Forbs	20.79	18.28	20
Grasses	20.26	19.17	20

**Table 21: Centennial Mine. Woody Species Density.**  
Reference Area: Aspen/Grass (GVH-08).

SPECIES	Individuals Per Acre
<i>Artemisia tridentata</i>	185.12
<i>Gutierrezia sarothrae</i>	879.32
<i>Populus tremuloides</i>	833.04
<i>Rosa woodsii</i>	462.80
<i>Symphoricarpos oreophilus</i>	1342.12
<b>TOTAL</b>	<b>3702.40</b>



**FIG. 1.** A statistical comparison (Student's t-tests) of the **total living cover** between the proposed disturbed GVH sites and their reference areas.

	<u><math>\bar{x}</math></u>	<u>s</u>	<u>n</u>	<u>t</u>	<u>df</u>	<u>SL</u>
<b>GVH-04 (S/G)</b>						
<u>Proposed Disturbed:</u>	58.13	11.05	40			
<u>Reference Area:</u>	62.25	8.51	40			
t-test				-1.868	78	N.S.
<b>GVH-05A (S/G)</b>						
<u>Proposed Disturbed:</u>	59.75	9.81	20			
<u>Reference Area:</u>	62.25	8.51	40			
t-test				-1.019	58	N.S.
<b>GVH-07 (S/G)</b>						
<u>Proposed Disturbed:</u>	60.25	10.30	20			
<u>Reference Area:</u>	62.25	8.51	40			
t-test				-0.799	58	N.S.
<b>GVH-08 (A/G)</b>						
<u>Proposed Disturbed:</u>	70.25	21.76	20			
<u>Reference Area:</u>	76.25	18.43	20			
t-test				-0.941	38	N.S.
<b>GVH-09 (S/G)</b>						
<u>Proposed Disturbed:</u>	54.00	11.25	20			
<u>Reference Area:</u>	62.25	8.51	40			
t-test				-3.173	58	p<0.01

$\bar{x}$  = mean

S/G = sagebrush/grass community

A/G = aspen/grass community

s = standard deviation

n = sample size

t = Student's t-value

df = degrees of freedom

SL= Significance Level

N.S.=Non-Significant



**FIG. 2.** A statistical comparison (Student's t-tests) of the **woody species density** between the proposed disturbed GVH sites and their reference areas.

	<u><math>\bar{x}</math></u>	<u>s</u>	<u>n</u>	<u>t</u>	<u>df</u>	<u>SL</u>
<b>GVH-04 (S/G)</b>						
<u>Proposed Disturbed:</u>	12787.03	6969.89	40			
<u>Reference Area:</u>	13025.18	8609.87	40			
t-test				-0.136	78	N.S.
<b>GVH-05A (S/G)</b>						
<u>Proposed Disturbed:</u>	5785.93	2694.85	20			
<u>Reference Area:</u>	13025.18	8609.87	40			
t-test				-3.657	58	p<0.01
<b>GVH-07 (S/G)</b>						
<u>Proposed Disturbed:</u>	6944.14	3217.85	20			
<u>Reference Area:</u>	13025.18	8609.87	40			
t-test				-3.043	58	p<0.01
<b>GVH-08 (A/G)</b>						
<u>Proposed Disturbed:</u>	2645.94	2361.07	20			
<u>Reference Area:</u>	3702.40	2706.98	20			
t-test				-1.315	38	N.S.
<b>GVH-09 (S/G)</b>						
<u>Proposed Disturbed:</u>	3678.28	2117.18	20			
<u>Reference Area:</u>	13025.18	8609.87	40			
t-test				-4.765	58	p<0.01

$\bar{x}$  = mean

S/G = sagebrush/grass community

A/G = aspen/grass community

s = standard deviation

n = sample size

t = Student's t-value

df = degrees of freedom

SL= Significance Level

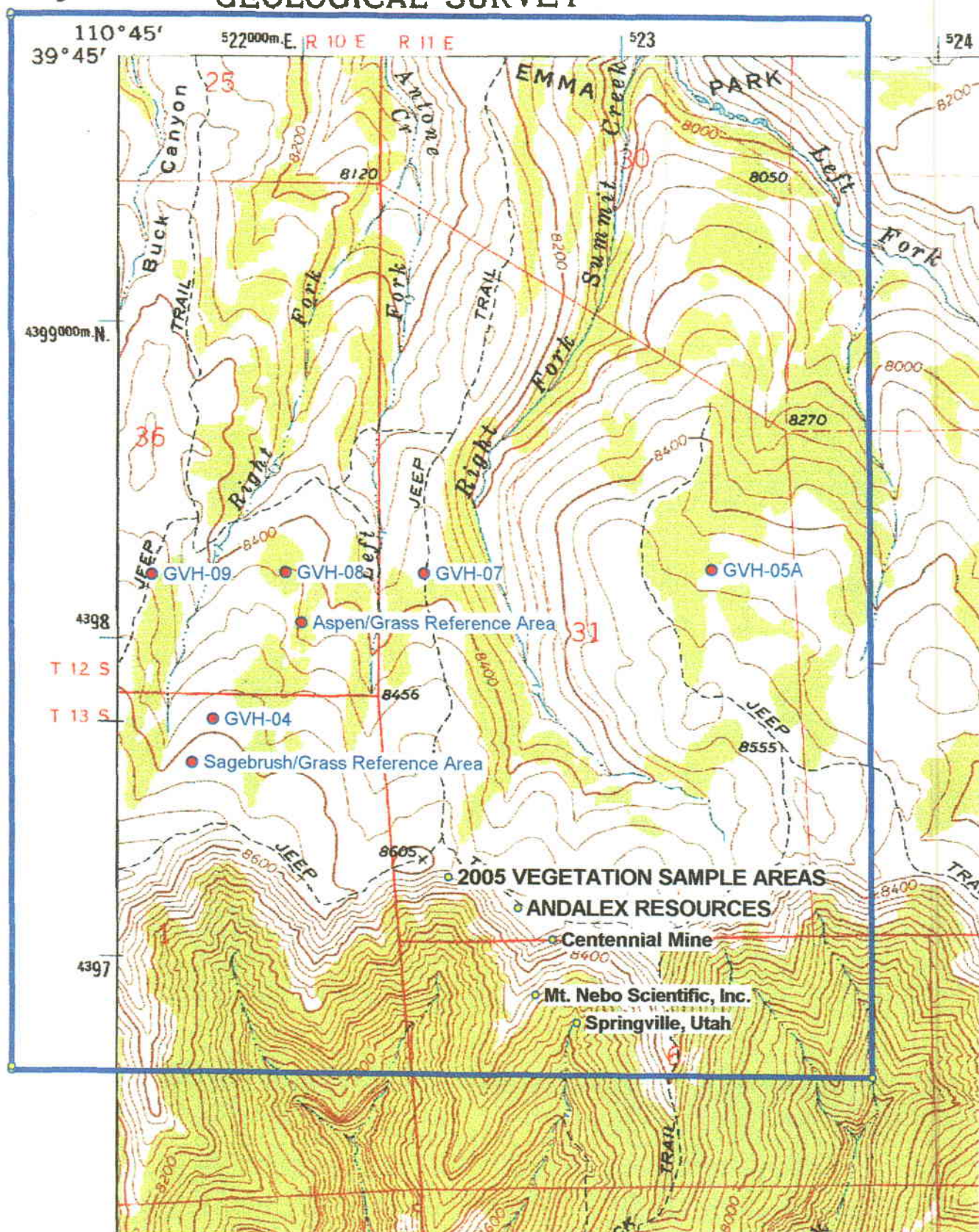
N.S.= Non-Significant



3863 IV SE  
(MATT'S SUMMIT)

- DEADMAN CANYON, UT
- 7.5 Minute Series Quadrangle Map

UNITED STATES  
DEPARTMENT OF THE INTERIOR  
GEOLOGICAL SURVEY







GVH-04



GVH-04 Access Road





GVH-05A



GVH-07





GVH-08



GVH-09





Sagebrush/Grass Reference Area



Aspen/Grass Reference Area

# APPENDIX

(Raw Data)



ANDALEX

Centennial Mine

Proposed Disturbed GVH-4

Access Road & Drill Site

Exposure: N

Slope: 8 deg.

Sample Date: 16 June 2005

CONTINUED SITES IN TAB B

1 thru 20 Drill Pad

	1.00	2.00	3.00	4.00	5.00	6.00	7.00
<b>TREES &amp; SHRUBS</b>							
<i>Artemisia tridentata</i>	29.00	7.00	40.00	5.00	0.00	5.00	12.00
<i>Chrysothamnus viscidiflorus</i>	0.00	10.00	0.00	20.00	11.00	20.00	13.00
<i>Symphoricarpos oreophilus</i>	0.00	0.00	0.00	10.00	0.00	5.00	0.00
<b>FORBS</b>							
<i>Achillea millefolium</i>	0.00	0.00	0.00	5.00	5.00	2.00	0.00
<i>Astragalus sp.</i>	2.00	3.00	0.00	0.00	0.00	0.00	0.00
<i>Clematis hirsutissima</i>	0.00	0.00	0.00	0.00	0.00	0.00	0.00
<i>Collinsia parvifolia</i>	0.00	0.00	0.00	0.00	0.00	0.00	0.00
<i>Cymopterus longipes</i>	0.00	0.00	0.00	0.00	0.00	0.00	0.00
<i>Delphinium nelsonii</i>	7.00	15.00	10.00	10.00	8.00	0.00	10.00
<i>Erigeron engelmannii</i>	0.00	0.00	0.00	0.00	0.00	5.00	0.00
<i>Gilia leptomeria</i>	0.00	0.00	0.00	5.00	5.00	0.00	0.00
<i>Lupinus argenteus</i>	0.00	0.00	0.00	0.00	0.00	0.00	0.00
<i>Penstemon watsonii</i>	8.00	3.00	0.00	15.00	3.00	0.00	0.00
<i>Phlox longifolia</i>	0.00	0.00	5.00	0.00	0.00	5.00	0.00
<i>Potentilla concinna</i>	0.00	0.00	0.00	0.00	0.00	0.00	0.00
<i>Taraxacum officinale</i>	1.00	0.00	5.00	0.00	0.00	5.00	0.00
<i>Viola nuttallii</i>	3.00	7.00	5.00	0.00	3.00	3.00	5.00
<b>GRASSES</b>							
<i>Elymus salinus</i>	0.00	0.00	5.00	0.00	0.00	5.00	5.00
<i>Festuca ovina</i>	0.00	0.00	0.00	0.00	0.00	0.00	0.00
<i>Poa compressa</i>	5.00	0.00	0.00	0.00	0.00	0.00	0.00
<i>Poa secunda</i>	0.00	5.00	0.00	0.00	0.00	5.00	0.00
<i>Stipa columbiana</i>	0.00	0.00	0.00	0.00	0.00	0.00	0.00
<b>COVER</b>							
Total Living Cover	55.00	50.00	70.00	70.00	35.00	60.00	45.00
Litter	13.00	23.00	8.00	9.00	19.00	19.00	24.00
Bareground	30.00	25.00	20.00	20.00	45.00	20.00	30.00
Rock	2.00	2.00	2.00	1.00	1.00	1.00	1.00
<b>% COMPOSITION</b>							
Shrubs	52.73	34.00	57.14	50.00	31.43	50.00	55.56
Forbs	38.18	56.00	35.71	50.00	68.57	33.33	33.33
Grasses	9.09	10.00	7.14	0.00	0.00	16.67	11.11

8.00	9.00	10.00	11.00	12.00	13.00	14.00	15.00	16.00	17.00
0.00	15.00	29.00	0.00	3.00	15.00	5.00	25.00	10.00	0.00
10.00	15.00	20.00	10.00	20.00	20.00	0.00	15.00	25.00	25.00
2.00	0.00	0.00	0.00	0.00	15.00	0.00	0.00	0.00	0.00
0.00	0.00	0.00	10.00	0.00	0.00	5.00	0.00	0.00	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
7.00	5.00	10.00	0.00	10.00	10.00	10.00	5.00	10.00	10.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3.00	5.00	0.00	5.00	2.00	0.00	5.00	5.00	5.00	15.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
7.00	2.00	0.00	0.00	0.00	0.00	5.00	0.00	5.00	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.00	3.00	0.00	0.00	5.00	0.00	0.00	0.00	0.00	0.00
0.00	5.00	1.00	5.00	0.00	0.00	5.00	5.00	5.00	5.00
13.00	5.00	8.00	10.00	10.00	5.00	8.00	5.00	5.00	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3.00	10.00	2.00	10.00	0.00	5.00	7.00	5.00	0.00	10.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
45.00	65.00	70.00	50.00	50.00	70.00	50.00	65.00	65.00	65.00
19.00	14.00	19.00	24.00	14.00	14.00	14.00	24.00	14.00	30.00
35.00	20.00	10.00	25.00	1.00	15.00	35.00	10.00	20.00	4.00
1.00	1.00	1.00	1.00	35.00	1.00	1.00	1.00	1.00	1.00
26.67	46.15	70.00	20.00	46.00	71.43	10.00	61.54	53.85	38.46
37.78	30.77	15.71	40.00	34.00	14.29	60.00	23.08	38.46	46.15
35.56	23.08	14.29	40.00	20.00	14.29	30.00	15.38	7.69	15.38

20 thru 40 Access Road

18.00	19.00	20.00	21.00	22.00	23.00	24.00	25.00	26.00	27.00
20.00	43.00	10.00	10.00	15.00	40.00	0.00	0.00	0.00	10.00
5.00	0.00	15.00	20.00	15.00	5.00	40.00	30.00	20.00	0.00
0.00	10.00	0.00	0.00	0.00	10.00	0.00	0.00	0.00	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.00	2.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
5.00	5.00	10.00	5.00	5.00	5.00	0.00	10.00	10.00	10.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
5.00	0.00	0.00	3.00	0.00	5.00	5.00	5.00	0.00	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
5.00	5.00	0.00	2.00	0.00	5.00	0.00	0.00	0.00	0.00
0.00	0.00	5.00	0.00	0.00	0.00	0.00	0.00	5.00	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	5.00	0.00	0.00
5.00	0.00	0.00	5.00	5.00	5.00	5.00	0.00	0.00	0.00
5.00	5.00	5.00	5.00	10.00	0.00	0.00	0.00	5.00	20.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.00	5.00	10.00	0.00	5.00	0.00	5.00	0.00	0.00	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	15.00	10.00	0.00
50.00	75.00	55.00	50.00	55.00	75.00	55.00	65.00	50.00	40.00
15.00	15.00	10.00	24.00	9.00	15.00	4.00	25.00	9.00	9.00
30.00	5.00	30.00	25.00	35.00	9.00	40.00	9.00	40.00	50.00
5.00	5.00	5.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
50.00	70.67	45.45	60.00	54.55	73.33	72.73	46.15	40.00	25.00
40.00	16.00	27.27	30.00	18.18	26.67	18.18	30.77	30.00	25.00
10.00	13.33	27.27	10.00	27.27	0.00	9.09	23.08	30.00	50.00

28.00	29.00	30.00	31.00	32.00	33.00	34.00	35.00	36.00	37.00
38.00	20.00	5.00	7.00	20.00	30.00	20.00	20.00	10.00	20.00
0.00	5.00	45.00	15.00	15.00	35.00	10.00	10.00	5.00	10.00
0.00	0.00	0.00	8.00	0.00	0.00	0.00	0.00	0.00	7.00

0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	5.00	0.00	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	2.00	0.00
10.00	15.00	10.00	5.00	7.00	5.00	10.00	5.00	0.00	5.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	5.00	5.00
0.00	0.00	5.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	5.00	18.00
0.00	0.00	0.00	5.00	0.00	0.00	0.00	0.00	0.00	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.00	0.00	0.00	0.00	5.00	0.00	10.00	0.00	0.00	0.00

10.00	0.00	5.00	0.00	10.00	0.00	15.00	5.00	0.00	0.00
0.00	0.00	0.00	10.00	0.00	0.00	0.00	0.00	13.00	5.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
5.00	5.00	5.00	0.00	3.00	5.00	0.00	5.00	0.00	0.00

65.00	45.00	75.00	50.00	60.00	75.00	65.00	50.00	40.00	70.00
19.00	14.00	9.00	9.00	14.00	15.00	20.00	14.00	19.00	20.00
15.00	40.00	15.00	40.00	25.00	9.00	14.00	35.00	40.00	9.00
1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00

58.46	55.56	66.67	60.00	58.33	86.67	46.15	60.00	37.50	52.86
18.46	33.33	20.00	20.00	20.00	6.67	30.77	20.00	30.00	40.00
23.08	11.11	13.33	20.00	21.67	6.67	23.08	20.00	32.50	7.14

ANDALEX  
 Centennial Mine  
 Proposed Disturbed GVH-4  
 Access Road & Drill Site  
 Exposure: N  
 Slope: 8 deg.  
 Sample Date: 16 June 2005

38.00	39.00	40.00	Mean	SDev	Freq	
						TREES & SHRUBS
0.00	45.00	30.00	15.33	13.38	80.00	<i>Artemisia tridentata</i>
5.00	0.00	0.00	13.48	11.07	80.00	<i>Chrysothamnus viscidiflorus</i>
5.00	0.00	0.00	1.80	3.75	22.50	<i>Symphoricarpos oreophilus</i>
						FORBS
0.00	0.00	0.00	0.68	2.00	12.50	<i>Achillea millefolium</i>
0.00	0.00	0.00	0.13	0.56	5.00	<i>Astragalus</i> sp.
0.00	0.00	0.00	0.05	0.31	2.50	<i>Clematis hirsutissima</i>
0.00	0.00	0.00	0.18	0.83	5.00	<i>Collinsia parvifolia</i>
0.00	5.00	5.00	0.30	1.12	7.50	<i>Cymopterus longipes</i>
3.00	0.00	0.00	6.93	3.96	85.00	<i>Delphinium nelsonii</i>
0.00	0.00	5.00	0.50	1.50	10.00	<i>Erigeron engelmannii</i>
0.00	0.00	0.00	2.08	3.06	40.00	<i>Gilia leptomeria</i>
5.00	0.00	0.00	0.13	0.78	2.50	<i>Lupinus argenteus</i>
0.00	0.00	0.00	2.20	4.01	35.00	<i>Penstemon watsonii</i>
0.00	5.00	5.00	0.88	1.90	17.50	<i>Phlox longifolia</i>
0.00	0.00	5.00	0.13	0.78	2.50	<i>Potentilla concinna</i>
10.00	0.00	0.00	0.85	2.13	17.50	<i>Taraxacum officinale</i>
7.00	10.00	0.00	2.85	2.96	55.00	<i>Viola nuttallii</i>
						GRASSES
0.00	0.00	15.00	4.98	5.02	62.00	<i>Elymus salinus</i>
0.00	0.00	0.00	0.70	2.62	7.50	<i>Festuca ovina</i>
0.00	0.00	0.00	0.13	0.78	2.50	<i>Poa compressa</i>
0.00	0.00	0.00	2.18	3.35	35.00	<i>Poa secunda</i>
10.00	5.00	0.00	1.70	3.42	25.00	<i>Stipa columbiana</i>
						COVER
45.00	70.00	65.00	58.13	11.05		Total Living Cover
45.00	14.00	14.00	16.55	7.22		Litter
9.00	15.00	20.00	23.10	12.57		Bareground
1.00	1.00	1.00	2.23	5.35		Rock
						% COMPOSITION
22.22	64.29	46.15	50.69	16.14		Shrubs
55.56	28.57	30.77	31.79	13.16		Forbs
22.22	7.14	23.08	17.52	10.89		Grasses

ANDALEX

Centennial Mine

Reference Area GVH-4

Sagebrush/Low Rabbit Brush

Exposure:

Slope:

Sample Date: 16 June 2005

	1.00	2.00	3.00	4.00	5.00	6.00	7.00
<b>TREES &amp; SHRUBS</b>							
<i>Amelanchier utahensis</i>	0.00	0.00	0.00	0.00	0.00	0.00	0.00
<i>Artemisia tridentata</i>	45.00	20.00	5.00	10.00	25.00	0.00	40.00
<i>Chrysothamnus viscidiflorus</i>	0.00	0.00	10.00	10.00	5.00	25.00	10.00
<i>Symphoricarpos oreophilus</i>	0.00	0.00	0.00	0.00	0.00	0.00	0.00
<b>FORBS</b>							
<i>Achillea millefolium</i>	0.00	0.00	0.00	0.00	0.00	0.00	0.00
<i>Antennaria dimorpha</i>	0.00	0.00	0.00	0.00	0.00	5.00	0.00
<i>Arabis holboellii</i>	0.00	0.00	0.00	0.00	0.00	0.00	0.00
<i>Astragalus sp.</i>	0.00	0.00	0.00	0.00	0.00	0.00	2.00
<i>Collinsia parvifolia</i>	0.00	0.00	0.00	0.00	0.00	0.00	0.00
<i>Cymopterus longipes</i>	5.00	8.00	5.00	0.00	5.00	5.00	3.00
<i>Delphinium nelsonii</i>	0.00	5.00	5.00	5.00	0.00	5.00	0.00
<i>Erigeron engelmannii</i>	8.00	2.00	0.00	0.00	2.00	5.00	0.00
<i>Eriogonum sp.</i>	0.00	0.00	0.00	5.00	0.00	0.00	0.00
<i>Gilia leptomeria</i>	0.00	0.00	0.00	5.00	0.00	0.00	0.00
<i>Lupinus argenteus</i>	0.00	0.00	5.00	5.00	0.00	0.00	0.00
<i>Penstemon watsonii</i>	7.00	0.00	15.00	5.00	10.00	5.00	5.00
<i>Phlox longifolia</i>	0.00	5.00	0.00	2.00	3.00	0.00	0.00
<i>Potentilla concinna</i>	0.00	0.00	0.00	0.00	0.00	0.00	0.00
<i>Senecio multilobatus</i>	0.00	0.00	0.00	3.00	0.00	0.00	0.00
<i>Taraxacum officinale</i>	0.00	0.00	5.00	0.00	0.00	0.00	0.00
<i>Viola nuttallii</i>	0.00	0.00	0.00	0.00	5.00	0.00	0.00
<b>GRASSES</b>							
<i>Elymus salinus</i>	0.00	0.00	5.00	0.00	0.00	5.00	0.00
<i>Festuca ovina</i>	0.00	0.00	0.00	5.00	5.00	0.00	0.00
<i>Poa secunda</i>	5.00	10.00	0.00	0.00	0.00	0.00	5.00
<i>Stipa columbiana</i>	0.00	0.00	0.00	0.00	5.00	0.00	5.00
<b>COVER</b>							
Total Living Cover	70.00	50.00	55.00	55.00	65.00	55.00	70.00
Litter	20.00	15.00	10.00	25.00	10.00	15.00	20.00
Bareground	5.00	30.00	30.00	15.00	5.00	25.00	5.00
Rock	5.00	5.00	5.00	5.00	20.00	5.00	5.00
<b>% COMPOSITION</b>							
Shrubs	64.29	40.00	27.27	36.36	46.15	45.45	71.43
Forbs	28.57	40.00	63.64	54.55	38.46	45.45	14.29
Grasses	7.14	20.00	9.09	9.09	15.38	9.09	14.29

8.00	9.00	10.00	11.00	12.00	13.00	14.00	15.00	16.00	17.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
45.00	20.00	0.00	15.00	10.00	10.00	15.00	10.00	28.00	45.00
0.00	20.00	50.00	0.00	10.00	28.00	10.00	5.00	0.00	0.00
0.00	0.00	0.00	5.00	0.00	0.00	0.00	0.00	5.00	0.00
0.00	0.00	0.00	0.00	3.00	0.00	0.00	0.00	0.00	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.00	0.00	0.00	0.00	3.00	0.00	0.00	0.00	0.00	0.00
0.00	0.00	3.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	2.00	0.00	0.00
5.00	5.00	5.00	5.00	5.00	5.00	5.00	0.00	0.00	0.00
5.00	5.00	0.00	10.00	2.00	7.00	5.00	10.00	10.00	10.00
0.00	0.00	0.00	0.00	0.00	5.00	0.00	10.00	0.00	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.00	0.00	0.00	0.00	7.00	0.00	0.00	0.00	5.00	5.00
5.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	5.00	0.00
5.00	5.00	5.00	15.00	10.00	0.00	10.00	5.00	5.00	0.00
0.00	0.00	0.00	5.00	0.00	0.00	0.00	3.00	0.00	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	5.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
5.00	0.00	2.00	5.00	0.00	0.00	0.00	0.00	2.00	0.00
0.00	0.00	0.00	5.00	0.00	0.00	5.00	0.00	5.00	0.00
5.00	10.00	0.00	0.00	0.00	10.00	5.00	5.00	5.00	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	5.00	0.00	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	10.00
75.00	65.00	65.00	65.00	50.00	65.00	55.00	55.00	70.00	75.00
10.00	8.00	19.00	19.00	30.00	25.00	30.00	5.00	15.00	15.00
10.00	25.00	15.00	15.00	15.00	5.00	10.00	10.00	10.00	5.00
5.00	2.00	1.00	1.00	5.00	5.00	5.00	30.00	5.00	5.00
60.00	61.54	76.92	30.77	40.00	58.46	45.45	27.27	47.14	60.00
33.33	23.08	23.08	69.23	60.00	26.15	45.45	54.55	45.71	26.67
6.67	15.38	0.00	0.00	0.00	15.38	9.09	18.18	7.14	13.33



18.00	19.00	20.00	21.00	22.00	23.00	24.00	25.00	26.00	27.00
5.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
30.00	15.00	5.00	0.00	40.00	20.00	25.00	60.00	15.00	30.00
0.00	20.00	0.00	20.00	25.00	5.00	10.00	5.00	15.00	0.00
5.00	0.00	5.00	0.00	10.00	10.00	5.00	0.00	10.00	5.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
5.00	0.00	5.00	5.00	0.00	5.00	0.00	5.00	5.00	3.00
10.00	15.00	15.00	0.00	0.00	0.00	0.00	0.00	5.00	0.00
0.00	0.00	0.00	0.00	0.00	5.00	0.00	0.00	0.00	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
10.00	10.00	10.00	10.00	5.00	5.00	10.00	5.00	5.00	2.00
0.00	0.00	5.00	0.00	0.00	3.00	5.00	0.00	0.00	10.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.00	0.00	0.00	5.00	0.00	2.00	0.00	0.00	0.00	5.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	5.00	0.00
0.00	10.00	10.00	0.00	0.00	10.00	0.00	0.00	10.00	0.00
0.00	0.00	0.00	15.00	0.00	0.00	0.00	5.00	0.00	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	10.00
0.00	0.00	0.00	0.00	0.00	0.00	5.00	0.00	0.00	0.00
65.00	70.00	55.00	55.00	80.00	65.00	60.00	80.00	70.00	65.00
25.00	20.00	35.00	19.00	4.00	30.00	19.00	8.00	25.00	30.00
5.00	5.00	5.00	25.00	15.00	4.00	20.00	10.00	4.00	4.00
5.00	5.00	5.00	1.00	1.00	1.00	1.00	2.00	1.00	1.00
61.54	50.00	18.18	36.36	93.75	53.85	66.67	81.25	57.14	53.85
38.46	35.71	63.64	36.36	6.25	30.77	25.00	12.50	28.57	30.77
0.00	14.29	18.18	27.27	0.00	15.38	8.33	6.25	14.29	15.38

28.00	29.00	30.00	31.00	32.00	33.00	34.00	35.00	36.00	37.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3.00	15.00	5.00	5.00	0.00	10.00	5.00	15.00	15.00	40.00
20.00	15.00	5.00	25.00	10.00	15.00	30.00	0.00	20.00	5.00
12.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	15.00
0.00	0.00	0.00	0.00	0.00	0.00	5.00	0.00	0.00	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2.00	5.00	0.00	0.00	5.00	0.00	5.00	0.00	0.00	0.00
3.00	10.00	15.00	15.00	5.00	10.00	10.00	10.00	10.00	0.00
0.00	0.00	5.00	0.00	0.00	5.00	0.00	0.00	0.00	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.00	0.00	0.00	0.00	5.00	0.00	0.00	0.00	0.00	0.00
2.00	0.00	0.00	0.00	0.00	0.00	0.00	5.00	0.00	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.00	0.00	0.00	0.00	0.00	0.00	5.00	0.00	0.00	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
5.00	0.00	5.00	5.00	0.00	0.00	0.00	0.00	5.00	0.00
3.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.00	15.00	20.00	0.00	5.00	10.00	0.00	10.00	15.00	0.00
0.00	5.00	10.00	10.00	30.00	0.00	0.00	0.00	0.00	5.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
50.00	65.00	65.00	60.00	60.00	50.00	60.00	40.00	65.00	65.00
19.00	8.00	15.00	9.00	9.00	9.00	14.00	4.00	25.00	30.00
30.00	25.00	19.00	30.00	30.00	40.00	25.00	55.00	8.00	4.00
1.00	2.00	1.00	1.00	1.00	1.00	1.00	1.00	2.00	1.00
70.00	46.15	15.38	50.00	16.67	50.00	58.33	37.50	53.85	92.31
30.00	23.08	38.46	33.33	25.00	30.00	41.67	37.50	23.08	0.00
0.00	30.77	46.15	16.67	58.33	20.00	0.00	25.00	23.08	7.69

ANDALEX  
 Centennial Mine  
 Reference Area GVH-4  
 Sagebrush/Low Rabbit Brush  
 Exposure:  
 Slope:  
 Sample Date: 16 June 2005

38.00	39.00	40.00	Mean	SDev	Freq	
						TREES & SHRUBS
0.00	0.00	0.00	0.13	0.78	2.50	<i>Amelanchier utahensis</i>
15.00	45.00	15.00	19.28	15.27	90.00	<i>Artemisia tridentata</i>
0.00	0.00	20.00	11.20	11.14	70.00	<i>Chrysothamnus viscidiflorus</i>
10.00	0.00	10.00	2.68	4.28	32.50	<i>Symphoricarpos oreophilus</i>
						FORBS
0.00	0.00	0.00	0.20	0.90	5.00	<i>Achillea millefolium</i>
0.00	0.00	0.00	0.13	0.78	2.50	<i>Antennaria dimorpha</i>
0.00	0.00	0.00	0.08	0.47	2.50	<i>Arabis holboellii</i>
0.00	0.00	0.00	0.13	0.56	5.00	<i>Astragalus sp.</i>
0.00	0.00	0.00	0.05	0.31	2.50	<i>Collinsia parvifolia</i>
3.00	5.00	0.00	3.10	2.43	65.00	<i>Cymopterus longipes</i>
15.00	5.00	0.00	5.93	5.08	70.00	<i>Delphinium nelsonii</i>
0.00	5.00	0.00	1.30	2.52	25.00	<i>Erigeron engelmannii</i>
0.00	0.00	0.00	0.13	0.78	2.50	<i>Eriogonum sp.</i>
0.00	0.00	10.00	0.80	2.23	12.50	<i>Gilia leptomeria</i>
0.00	0.00	0.00	0.63	1.65	12.50	<i>Lupinus argenteus</i>
10.00	0.00	0.00	4.90	4.39	67.50	<i>Penstemon watsonii</i>
0.00	0.00	0.00	1.03	2.17	22.50	<i>Phlox longifolia</i>
0.00	0.00	0.00	0.25	1.09	5.00	<i>Potentilla concinna</i>
0.00	0.00	0.00	0.08	0.47	2.50	<i>Senecio multilobatus</i>
2.00	0.00	0.00	1.33	2.07	32.50	<i>Taraxacum officinale</i>
0.00	0.00	5.00	0.83	1.82	17.50	<i>Viola nuttallii</i>
						GRASSES
0.00	5.00	5.00	4.38	5.27	50.00	<i>Elymus salinus</i>
0.00	0.00	0.00	2.25	5.58	22.50	<i>Festuca ovina</i>
0.00	0.00	0.00	0.88	2.47	12.50	<i>Poa secunda</i>
0.00	0.00	0.00	0.63	2.00	10.00	<i>Stipa columbiana</i>
						COVER
55.00	65.00	65.00	62.25	8.51		Total Living Cover
19.00	10.00	25.00	17.55	8.27		Litter
25.00	20.00	9.00	16.30	11.66		Bareground
1.00	5.00	1.00	3.90	5.30		Rock
						% COMPOSITION
45.45	69.23	69.23	52.13	18.41		Shrubs
54.55	23.08	23.08	34.58	15.32		Forbs
0.00	7.69	7.69	13.29	12.03		Grasses

ANDALEX  
 Centennial Mine  
 Site GVH-5A  
 Sage/Grass  
 Exposure:  
 Slope:

Sample Date: 20 Sept 2005

1.00	2.00	3.00	4.00	5.00	6.00	7.00
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UNDERSTORY

SHRUBS

<i>Artemisia tridentata</i>	5.00	15.00	15.00	10.00	0.00	25.00	10.00
<i>Chrysothamnus viscidiflorus</i>	5.00	15.00	0.00	0.00	0.00	0.00	20.00
<i>Symphoricarpos oreophilus</i>	5.00	0.00	15.00	10.00	0.00	0.00	0.00

FORBS

<i>Aster sp.</i>	0.00	0.00	0.00	0.00	25.00	0.00	0.00
<i>Astragalus sp.</i>	5.00	5.00	0.00	0.00	0.00	0.00	0.00
<i>Cynoglossum officinale</i>	0.00	0.00	0.00	0.00	0.00	5.00	0.00
<i>Lupinus argenteus</i>	0.00	0.00	0.00	10.00	0.00	0.00	0.00
<i>Penstemon watsonii</i>	5.00	5.00	10.00	10.00	0.00	0.00	0.00
<i>Taraxicum officinale</i>	0.00	0.00	0.00	0.00	0.00	10.00	0.00

GRASSES

<i>Elymus spicatus</i>	10.00	0.00	0.00	0.00	0.00	0.00	15.00
<i>Poa pratensis</i>	0.00	10.00	20.00	0.00	30.00	25.00	10.00
<i>Stipa columbiana</i>	0.00	0.00	0.00	10.00	0.00	0.00	0.00

COVER

Understory	35.00	50.00	60.00	50.00	55.00	65.00	55.00
Litter	55.00	35.00	30.00	14.00	4.00	25.00	19.00
Bareground	9.00	14.00	8.00	35.00	40.00	8.00	25.00
Rock	1.00	1.00	2.00	1.00	1.00	2.00	1.00

% COMPOSITION

Shrubs	42.86	60.00	50.00	40.00	0.00	38.46	54.55
Forbs	28.57	20.00	16.67	40.00	45.45	23.08	0.00
Grasses	28.57	20.00	33.33	20.00	54.55	38.46	45.45

8.00	9.00	10.00	11.00	12.00	13.00	14.00	15.00	16.00	17.00
30.00	15.00	45.00	50.00	25.00	0.00	20.00	30.00	20.00	5.00
0.00	25.00	0.00	0.00	15.00	35.00	15.00	15.00	0.00	35.00
0.00	0.00	0.00	10.00	0.00	0.00	5.00	0.00	0.00	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.00	0.00	5.00	0.00	0.00	0.00	0.00	0.00	10.00	0.00
5.00	0.00	0.00	5.00	15.00	10.00	5.00	0.00	10.00	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.00	0.00	5.00	0.00	0.00	5.00	0.00	0.00	10.00	0.00
30.00	10.00	10.00	10.00	10.00	0.00	0.00	15.00	15.00	0.00
0.00	15.00	0.00	0.00	0.00	25.00	20.00	0.00	0.00	30.00
65.00	65.00	65.00	75.00	65.00	75.00	65.00	60.00	65.00	70.00
25.00	20.00	25.00	20.00	25.00	20.00	20.00	20.00	20.00	20.00
8.00	14.00	9.00	4.00	9.00	4.00	14.00	18.00	14.00	9.00
2.00	1.00	1.00	1.00	1.00	1.00	1.00	2.00	1.00	1.00
46.15	61.54	69.23	80.00	61.54	46.67	61.54	75.00	30.77	57.14
7.69	0.00	7.69	6.67	23.08	13.33	7.69	0.00	30.77	0.00
46.15	38.46	23.08	13.33	15.38	40.00	30.77	25.00	38.46	42.86

ANDALEX  
 Centennial Mine  
 Site GVH-5A  
 Sage/Grass  
 Exposure:  
 Slope:  
 Sample Date: 20 Sept 2005

18.00	19.00	20.00	Mean	SDev	Freq	
35.00	5.00	15.00	18.75	13.68	90.00	UNDERSTORY
0.00	0.00	10.00	9.50	11.61	50.00	SHRUBS
0.00	0.00	0.00	2.25	4.32	25.00	<i>Artemisia tridentata</i>
						<i>Chrysothamnus viscidiflorus</i>
						<i>Symphoricarpos oreophilus</i>

0.00	0.00	0.00	1.25	5.45	5.00	FORBS
0.00	0.00	0.00	0.50	1.50	10.00	<i>Aster sp.</i>
0.00	0.00	0.00	0.25	1.09	5.00	<i>Astragalus sp.</i>
0.00	5.00	15.00	2.25	4.32	25.00	<i>Cynoglossum officinale</i>
5.00	0.00	0.00	4.25	4.55	55.00	<i>Lupinus argenteus</i>
0.00	0.00	0.00	0.50	2.18	5.00	<i>Penstemon watsonii</i>
						<i>Taraxicum officinale</i>

5.00	0.00	0.00	2.50	4.33	30.00	GRASSES
5.00	15.00	20.00	11.75	9.39	75.00	<i>Elymus spicatus</i>
0.00	20.00	0.00	6.00	9.82	30.00	<i>Poa pratensis</i>
						<i>Stipa columbiana</i>

50.00	45.00	60.00	59.75	9.81		COVER
35.00	35.00	25.00	24.60	9.99		Understory
14.00	19.00	14.00	14.45	9.17		Litter
1.00	1.00	1.00	1.20	0.40		Bareground
						Rock

70.00	11.11	41.67	49.91	19.53		% COMPOSITION
10.00	11.11	25.00	15.84	13.04		Shrubs
20.00	77.78	33.33	34.25	14.82		Forbs
						Grasses



ANDALEX

Centennial Mine

Site GVH-07

Sage/Grass

Exposure: NW

Slope: 3 deg

Sample Date: 20 Sept 2005

	1.00	2.00	3.00	4.00	5.00	6.00	7.00
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UNDERSTORY

SHRUBS

<i>Artemisia tridentata</i>	25.00	20.00	10.00	55.00	25.00	10.00	0.00
<i>Chrysothamnus viscidiflorus</i>	5.00	15.00	30.00	10.00	15.00	25.00	15.00
<i>Symphoricarpos oreophilus</i>	5.00	0.00	0.00	0.00	0.00	0.00	0.00

FORBS

<i>Antennaria dimorpha</i>	0.00	0.00	0.00	0.00	0.00	0.00	0.00
<i>Lupinus argenteus</i>	0.00	0.00	10.00	0.00	0.00	0.00	0.00
<i>Penstemon watsonii</i>	0.00	0.00	0.00	0.00	0.00	0.00	0.00
<i>Taraxicum officinale</i>	0.00	0.00	0.00	0.00	0.00	0.00	10.00

GRASSES

<i>Elymus spicatus</i>	35.00	0.00	15.00	0.00	0.00	0.00	15.00
<i>Poa pratensis</i>	0.00	15.00	0.00	0.00	25.00	10.00	0.00
<i>Stipa columbiana</i>	0.00	0.00	0.00	10.00	0.00	0.00	0.00

COVER

Understory	70.00	50.00	65.00	75.00	65.00	45.00	40.00
Litter	15.00	35.00	15.00	20.00	10.00	30.00	45.00
Bareground	14.00	1.00	18.00	4.00	24.00	20.00	13.00
Rock	1.00	14.00	2.00	1.00	1.00	5.00	2.00

% COMPOSITION

Shrubs	50.00	70.00	61.54	86.67	61.54	77.78	37.50
Forbs	0.00	0.00	15.38	0.00	0.00	0.00	25.00
Grasses	50.00	30.00	23.08	13.33	38.46	22.22	37.50

8.00	9.00	10.00	11.00	12.00	13.00	14.00	15.00	16.00	17.00
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45.00	20.00	15.00	5.00	25.00	5.00	0.00	25.00	10.00	20.00
15.00	20.00	0.00	30.00	20.00	20.00	20.00	15.00	35.00	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.00	10.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	25.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

0.00	0.00	50.00	10.00	10.00	0.00	0.00	10.00	0.00	15.00
5.00	0.00	0.00	5.00	5.00	15.00	40.00	10.00	10.00	10.00
5.00	15.00	0.00	0.00	0.00	0.00	0.00	5.00	10.00	0.00

70.00	65.00	65.00	50.00	60.00	40.00	60.00	65.00	65.00	70.00
20.00	14.00	10.00	4.00	30.00	9.00	9.00	20.00	20.00	15.00
9.00	20.00	24.00	45.00	9.00	50.00	30.00	14.00	14.00	14.00
1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00

85.71	61.54	23.08	70.00	75.00	62.50	33.33	61.54	69.23	28.57
0.00	15.38	0.00	0.00	0.00	0.00	0.00	0.00	0.00	35.71
14.29	23.08	76.92	30.00	25.00	37.50	66.67	38.46	30.77	35.71

ANDALEX  
 Centennial Mine  
 Site GVH-07  
 Sage/Grass  
 Exposure: NW  
 Slope: 3 deg  
 Sample Date: 20 Sept 2005

18.00	19.00	20.00	Mean	SDev	Freq	
						UNDERSTORY
						SHRUBS
0.00	20.00	25.00	18.00	13.91	85.00	<i>Artemisia tridentata</i>
20.00	10.00	10.00	16.50	9.10	90.00	<i>Chrysothamnus viscidiflorus</i>
0.00	0.00	0.00	0.25	1.09	5.00	<i>Symphoricarpos oreophilus</i>
						FORBS
5.00	0.00	0.00	0.25	1.09	5.00	<i>Antennaria dimorpha</i>
0.00	0.00	0.00	0.50	2.18	5.00	<i>Lupinus argenteus</i>
15.00	0.00	20.00	3.50	7.43	20.00	<i>Penstemon watsonii</i>
0.00	0.00	0.00	0.50	2.18	5.00	<i>Taraxicum officinale</i>
						GRASSES
10.00	0.00	5.00	8.75	12.83	50.00	<i>Elymus spicatus</i>
0.00	35.00	10.00	9.75	11.34	65.00	<i>Poa pratensis</i>
0.00	0.00	0.00	2.25	4.32	25.00	<i>Stipa columbiana</i>
						COVER
50.00	65.00	70.00	60.25	10.30		Understory
9.00	25.00	20.00	18.75	9.93		Litter
40.00	9.00	9.00	19.05	12.92		Bareground
1.00	1.00	1.00	1.95	2.91		Rock
						% COMPOSITION
40.00	46.15	50.00	57.58	17.97		Shrubs
40.00	0.00	28.57	8.00	13.25		Forbs
20.00	53.85	21.43	34.41	16.27		Grasses

ANDALEX

Centennial Mine

Site GVH-08

Aspen Grove

Exposure: N

Slope: 3 deg

Sample Date: 19 Sept 2005

	1.00	2.00	3.00	4.00	5.00	6.00	7.00
<hr/>							
OVERSTORY							
<i>Populus tremuloides</i>	40.00	0.00	0.00	10.00	0.00	40.00	0.00
<hr/>							
UNDERSTORY							
SHRUBS							
<i>Amelanchier utahensis</i>	5.00	0.00	0.00	0.00	0.00	0.00	0.00
<i>Artemisia tridentata</i>	20.00	0.00	5.00	0.00	0.00	0.00	0.00
<i>Chrysothamnus viscidiflorus</i>	8.00	5.00	0.00	0.00	5.00	0.00	0.00
<i>Populus tremuloides</i>	0.00	15.00	5.00	10.00	0.00	0.00	0.00
<i>Rosa woodsii</i>	0.00	0.00	0.00	0.00	0.00	0.00	0.00
<i>Symphoricarpos oreophilus</i>	5.00	0.00	15.00	10.00	45.00	40.00	10.00
<hr/>							
FORBS							
<i>Achillea millefolium</i>	0.00	5.00	0.00	0.00	0.00	0.00	0.00
<i>Collomia linearis</i>	2.00	0.00	0.00	0.00	0.00	0.00	0.00
<i>Cynoglossum officinale</i>	0.00	0.00	0.00	0.00	0.00	5.00	0.00
<i>Lupinus argenteus</i>	15.00	0.00	0.00	0.00	5.00	0.00	5.00
<i>Potentilla concinna</i>	0.00	0.00	0.00	0.00	0.00	0.00	0.00
<i>Taraxacum officinale</i>	0.00	0.00	5.00	10.00	5.00	0.00	20.00
<hr/>							
GRASSES							
<i>Elymus spicatus</i>	0.00	0.00	0.00	0.00	0.00	10.00	0.00
<i>Elymus trachycaulus</i>	0.00	0.00	0.00	0.00	0.00	0.00	0.00
<i>Poa pratensis</i>	15.00	0.00	10.00	0.00	0.00	0.00	35.00
<i>Stipa columbiana</i>	0.00	0.00	10.00	10.00	5.00	10.00	0.00
<hr/>							
COVER							
Overstory	40.00	0.00	0.00	10.00	0.00	40.00	0.00
Understory	70.00	25.00	50.00	40.00	65.00	65.00	70.00
Litter	20.00	50.00	10.00	10.00	15.00	15.00	10.00
Bareground	9.00	24.00	35.00	45.00	15.00	19.00	19.00
Rock	1.00	1.00	5.00	5.00	5.00	1.00	1.00
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% COMPOSITION							
Shrubs	54.29	80.00	50.00	50.00	76.92	61.54	14.29
Forbs	24.29	20.00	10.00	25.00	15.38	7.69	35.71
Grasses	21.43	0.00	40.00	25.00	7.69	30.77	50.00
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Overstory + Understory	110.00	25.00	50.00	50.00	65.00	105.00	70.00
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8.00	9.00	10.00	11.00	12.00	13.00	14.00	15.00	16.00	17.00
0.00	10.00	15.00	50.00	0.00	0.00	25.00	0.00	0.00	10.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.00	0.00	0.00	0.00	0.00	0.00	5.00	0.00	0.00	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.00	0.00	10.00	0.00	0.00	10.00	10.00	15.00	0.00	0.00
0.00	0.00	5.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.00	0.00	0.00	30.00	75.00	50.00	0.00	25.00	0.00	0.00
0.00	10.00	0.00	0.00	0.00	0.00	10.00	0.00	10.00	5.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.00	0.00	0.00	0.00	0.00	0.00	5.00	0.00	5.00	0.00
0.00	5.00	10.00	0.00	0.00	0.00	0.00	0.00	5.00	10.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
30.00	15.00	10.00	0.00	0.00	0.00	0.00	5.00	5.00	5.00
0.00	0.00	0.00	0.00	0.00	5.00	0.00	10.00	0.00	0.00
0.00	0.00	0.00	0.00	0.00	0.00	10.00	0.00	0.00	0.00
40.00	40.00	30.00	35.00	0.00	0.00	0.00	0.00	25.00	25.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.00	10.00	15.00	50.00	0.00	0.00	25.00	0.00	0.00	10.00
70.00	70.00	65.00	65.00	75.00	65.00	40.00	55.00	50.00	45.00
15.00	25.00	25.00	30.00	20.00	30.00	15.00	35.00	9.00	30.00
14.00	4.00	9.00	4.00	4.00	4.00	40.00	9.00	40.00	24.00
1.00	1.00	1.00	1.00	1.00	1.00	5.00	1.00	1.00	1.00
0.00	0.00	23.08	46.15	100.00	92.31	37.50	72.73	0.00	0.00
42.86	42.86	30.77	0.00	0.00	0.00	37.50	9.09	50.00	44.44
57.14	57.14	46.15	53.85	0.00	7.69	25.00	18.18	50.00	55.56
70.00	80.00	80.00	115.00	75.00	65.00	65.00	55.00	50.00	55.00

ANDALEX  
 Centennial Mine  
 Site GVH-08  
 Aspen Grove  
 Exposure: N  
 Slope: 3 deg  
 Sample Date: 19 Sept 2005

18.00	19.00	20.00	Mean	SDev	Freq	
						OVERSTORY
50.00	0.00	25.00	13.75	17.60	50.00	<i>Populus tremuloides</i>
						UNDERSTORY
						SHRUBS
0.00	0.00	0.00	0.25	1.09	5.00	<i>Amelanchier utahensis</i>
0.00	0.00	0.00	1.50	4.50	15.00	<i>Artemisia tridentata</i>
0.00	15.00	0.00	1.65	3.77	20.00	<i>Chrysothamnus viscidiflorus</i>
15.00	0.00	0.00	4.50	5.89	40.00	<i>Populus tremuloides</i>
0.00	0.00	0.00	0.25	1.09	5.00	<i>Rosa woodsii</i>
15.00	10.00	0.00	16.50	20.74	60.00	<i>Symphoricarpos oreophilus</i>
						FORBS
0.00	15.00	0.00	2.75	4.60	30.00	<i>Achillea millefolium</i>
0.00	0.00	0.00	0.10	0.44	5.00	<i>Collomia linearis</i>
0.00	0.00	0.00	0.75	1.79	15.00	<i>Cynoglossum officinale</i>
0.00	15.00	0.00	3.50	5.02	40.00	<i>Lupinus argenteus</i>
5.00	0.00	0.00	0.25	1.09	5.00	<i>Potentilla concinna</i>
0.00	0.00	0.00	5.50	7.89	50.00	<i>Taraxacum officinale</i>
						GRASSES
5.00	0.00	0.00	1.50	3.20	20.00	<i>Elymus spicatus</i>
0.00	0.00	0.00	0.50	2.18	5.00	<i>Elymus trachycaulus</i>
0.00	0.00	50.00	15.25	17.28	50.00	<i>Poa pratensis</i>
0.00	0.00	0.00	1.75	3.63	20.00	<i>Stipa columbiana</i>
						COVER
50.00	0.00	25.00	13.75	17.60		Overstory
40.00	55.00	50.00	56.50	13.24		Understory
35.00	30.00	35.00	23.20	10.82		Litter
24.00	14.00	14.00	18.50	12.60		Bareground
1.00	1.00	1.00	1.80	1.60		Rock
						% COMPOSITION
75.00	45.45	0.00	43.96	32.54		Shrubs
12.50	54.55	0.00	23.13	17.75		Forbs
12.50	0.00	100.00	32.91	25.35		Grasses
90.00	55.00	75.00	70.25	21.76		Overstory + Understory



ANDALEX  
 Centennial Mine  
 Site GVH-08 Reference Area  
 Aspen Reference Area

Exposure: E

Slope: 7 - 10 deg

Sample Date: 20 Sept 2005

	1.00	2.00	3.00	4.00	5.00	6.00	7.00
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OVERSTORY							
<i>Populus tremuloides</i>	15.00	50.00	35.00	0.00	0.00	55.00	0.00
UNDERSTORY							
SHRUBS							
<i>Artemisia tridentata</i>	0.00	0.00	0.00	0.00	5.00	0.00	0.00
<i>Chrysothamnus viscidiflorus</i>	10.00	0.00	0.00	10.00	25.00	30.00	10.00
<i>Populus tremuloides</i>	30.00	10.00	0.00	0.00	0.00	5.00	0.00
<i>Rosa woodsii</i>	0.00	0.00	0.00	0.00	0.00	0.00	0.00
<i>Symphoricarpos oreophilus</i>	0.00	0.00	15.00	0.00	0.00	0.00	35.00
FORBS							
<i>Achillea millefolium</i>	0.00	0.00	0.00	0.00	0.00	0.00	0.00
<i>Cynoglossum officinale</i>	0.00	0.00	0.00	0.00	0.00	0.00	0.00
<i>Lupinus argenteus</i>	15.00	15.00	25.00	20.00	10.00	5.00	0.00
GRASSES							
<i>Bromus carinatus</i>	0.00	0.00	0.00	0.00	0.00	0.00	0.00
<i>Elymus spicatus</i>	0.00	0.00	0.00	0.00	5.00	0.00	0.00
<i>Poa pratensis</i>	0.00	0.00	5.00	10.00	0.00	10.00	0.00
<i>Stipa columbiana</i>	0.00	0.00	0.00	0.00	0.00	0.00	5.00
COVER							
Overstory	15.00	50.00	35.00	0.00	0.00	55.00	0.00
Understory	55.00	25.00	45.00	40.00	45.00	50.00	50.00
Litter	30.00	4.00	40.00	55.00	9.00	8.00	24.00
Bareground	14.00	70.00	14.00	4.00	45.00	40.00	25.00
Rock	1.00	1.00	1.00	1.00	1.00	2.00	1.00
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% COMPOSITION							
Shrubs	72.73	40.00	33.33	25.00	66.67	70.00	90.00
Forbs	27.27	60.00	55.56	50.00	22.22	10.00	0.00
Grasses	0.00	0.00	11.11	25.00	11.11	20.00	10.00
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Overstory + Understory	70.00	75.00	80.00	40.00	45.00	105.00	50.00
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8.00	9.00	10.00	11.00	12.00	13.00	14.00	15.00	16.00	17.00
25.00	40.00	10.00	20.00	50.00	0.00	25.00	0.00	25.00	35.00
0.00	5.00	0.00	0.00	0.00	15.00	0.00	0.00	0.00	0.00
30.00	0.00	5.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.00	0.00	0.00	0.00	0.00	0.00	10.00	0.00	45.00	20.00
0.00	25.00	0.00	0.00	10.00	45.00	10.00	5.00	0.00	0.00
0.00	0.00	25.00	60.00	10.00	0.00	35.00	40.00	15.00	15.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.00	5.00	5.00	0.00	5.00	10.00	5.00	10.00	5.00	5.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.00	20.00	0.00	0.00	0.00	0.00	0.00	5.00	0.00	0.00
5.00	0.00	20.00	0.00	10.00	0.00	10.00	0.00	0.00	5.00
0.00	0.00	0.00	5.00	0.00	0.00	0.00	0.00	0.00	0.00
25.00	40.00	10.00	20.00	50.00	0.00	25.00	0.00	25.00	35.00
35.00	55.00	55.00	65.00	35.00	70.00	70.00	60.00	65.00	45.00
14.00	35.00	14.00	9.00	55.00	25.00	25.00	35.00	30.00	45.00
50.00	9.00	30.00	25.00	5.00	4.00	4.00	4.00	4.00	9.00
1.00	1.00	1.00	1.00	5.00	1.00	1.00	1.00	1.00	1.00
85.71	54.55	54.55	92.31	57.14	85.71	78.57	75.00	92.31	77.78
0.00	9.09	9.09	0.00	14.29	14.29	7.14	16.67	7.69	11.11
14.29	36.36	36.36	7.69	28.57	0.00	14.29	8.33	0.00	11.11
60.00	95.00	65.00	85.00	85.00	70.00	95.00	60.00	90.00	80.00

ANDALEX  
 Centennial Mine  
 Site GVH-08 Reference Area  
 Aspen Reference Area  
 Exposure: E  
 Slope: 7 - 10 deg  
 Sample Date: 20 Sept 2005

18.00	19.00	20.00	Mean	SDev	Freq	
						OVERSTORY
30.00	40.00	30.00	24.25	17.77	75.00	<i>Populus tremuloides</i>
						UNDERSTORY
						SHRUBS
0.00	0.00	0.00	1.25	3.49	15.00	<i>Artemisia tridentata</i>
0.00	0.00	0.00	6.00	10.07	35.00	<i>Chrysothamnus viscidiflorus</i>
0.00	0.00	10.00	6.50	11.84	35.00	<i>Populus tremuloides</i>
0.00	0.00	0.00	4.75	11.01	25.00	<i>Rosa woodsii</i>
0.00	5.00	0.00	12.75	17.06	50.00	<i>Symphoricarpos oreophilus</i>
						FORBS
5.00	0.00	0.00	0.25	1.09	5.00	<i>Achillea millefolium</i>
5.00	0.00	0.00	0.25	1.09	5.00	<i>Cynoglossum officinale</i>
15.00	15.00	15.00	9.25	6.76	85.00	<i>Lupinus argenteus</i>
						GRASSES
0.00	10.00	0.00	0.50	2.18	5.00	<i>Bromus carinatus</i>
0.00	0.00	0.00	1.50	4.50	15.00	<i>Elymus spicatus</i>
40.00	0.00	50.00	8.25	13.44	50.00	<i>Poa pratensis</i>
0.00	5.00	0.00	0.75	1.79	15.00	<i>Stipa columbiana</i>
						COVER
30.00	40.00	30.00	24.25	17.77		Overstory
65.00	35.00	75.00	52.00	13.55		Understory
25.00	40.00	20.00	27.10	14.70		Litter
9.00	24.00	4.00	19.65	18.42		Bareground
1.00	1.00	1.00	1.25	0.89		Rock
						% COMPOSITION
0.00	14.29	13.33	58.95	28.06		Shrubs
38.46	42.86	20.00	20.79	18.28		Forbs
61.54	42.86	66.67	20.26	19.17		Grasses
95.00	75.00	105.00	76.25	18.43		Overstory + Understory

ANDALEX

Centennial Mine

Site GVH-09

Sage/Grass

Exposure: E

Slope: 3 deg

Sample Date: 19 Sept 2005

	1.00	2.00	3.00	4.00	5.00	6.00	7.00
<hr/>							
UNDERSTORY							
SHRUBS							
<i>Artemisia tridentata</i>	0.00	0.00	0.00	25.00	0.00	0.00	0.00
<i>Chrysothamnus viscidiflorus</i>	0.00	0.00	5.00	5.00	15.00	0.00	0.00
<i>Symphoricarpos oreophilus</i>	0.00	0.00	0.00	0.00	0.00	0.00	0.00
FORBS							
<i>Achillea millefolium</i>	15.00	0.00	15.00	0.00	10.00	15.00	5.00
<i>Aster sp.</i>	0.00	0.00	0.00	35.00	5.00	0.00	40.00
<i>Cirsium sp.</i>	0.00	0.00	0.00	0.00	0.00	5.00	0.00
<i>Cynoglossum officinale</i>	0.00	0.00	0.00	0.00	0.00	0.00	0.00
<i>Lupinus argenteus</i>	0.00	0.00	0.00	0.00	0.00	0.00	7.00
<i>Penstemon watsonii</i>	0.00	0.00	0.00	0.00	0.00	0.00	0.00
<i>Polygonum aviculare</i>	15.00	10.00	30.00	0.00	0.00	10.00	10.00
<i>Taraxacum officinale</i>	20.00	45.00	5.00	0.00	5.00	0.00	0.00
GRASSES							
<i>Elymus spicatus</i>	0.00	0.00	0.00	0.00	0.00	0.00	0.00
<i>Elymus trachycaulus</i>	0.00	0.00	0.00	0.00	0.00	0.00	0.00
<i>Poa pratensis</i>	0.00	0.00	0.00	0.00	0.00	10.00	8.00
<i>Poa secunda</i>	0.00	0.00	0.00	0.00	5.00	0.00	0.00
<hr/>							
COVER							
Understory	50.00	55.00	55.00	65.00	40.00	40.00	70.00
Litter	5.00	5.00	4.00	10.00	4.00	4.00	19.00
Bareground	40.00	39.00	40.00	24.00	55.00	55.00	10.00
Rock	5.00	1.00	1.00	1.00	1.00	1.00	1.00
<hr/>							
% COMPOSITION							
Shrubs	0.00	0.00	9.09	46.15	37.50	0.00	0.00
Forbs	100.00	100.00	90.91	53.85	50.00	75.00	88.57
Grasses	0.00	0.00	0.00	0.00	12.50	25.00	11.43

8.00	9.00	10.00	11.00	12.00	13.00	14.00	15.00	16.00	17.00
0.00	10.00	15.00	25.00	20.00	15.00	25.00	15.00	35.00	15.00
0.00	0.00	0.00	0.00	0.00	10.00	0.00	0.00	0.00	0.00
0.00	0.00	0.00	0.00	0.00	0.00	8.00	0.00	5.00	0.00
0.00	20.00	0.00	0.00	0.00	5.00	5.00	0.00	0.00	5.00
35.00	15.00	5.00	5.00	15.00	0.00	0.00	0.00	0.00	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
5.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.00	0.00	0.00	0.00	0.00	0.00	7.00	0.00	0.00	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	5.00	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.00	0.00	10.00	10.00	0.00	0.00	0.00	0.00	0.00	0.00
0.00	0.00	0.00	0.00	0.00	15.00	5.00	5.00	0.00	5.00
0.00	0.00	0.00	0.00	15.00	0.00	0.00	0.00	0.00	0.00
25.00	20.00	10.00	20.00	0.00	0.00	0.00	25.00	10.00	25.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
65.00	65.00	40.00	60.00	50.00	45.00	50.00	45.00	55.00	50.00
19.00	24.00	19.00	24.00	29.00	28.00	30.00	19.00	25.00	24.00
15.00	10.00	40.00	15.00	20.00	25.00	15.00	35.00	10.00	25.00
1.00	1.00	1.00	1.00	1.00	2.00	5.00	1.00	10.00	1.00
0.00	15.38	37.50	41.67	40.00	55.56	66.00	33.33	72.73	30.00
61.54	53.85	37.50	25.00	30.00	11.11	24.00	0.00	9.09	10.00
38.46	30.77	25.00	33.33	30.00	33.33	10.00	66.67	18.18	60.00

ANDALEX  
 Centennial Mine  
 Site GVH-09  
 Sage/Grass  
 Exposure: E  
 Slope: 3 deg  
 Sample Date: 19 Sept 2005

18.00	19.00	20.00	Mean	SDev	Freq	
						UNDERSTORY
						SHRUBS
0.00	60.00	55.00	15.75	17.56	60.00	<i>Artemisia tridentata</i>
15.00	5.00	0.00	2.75	4.87	30.00	<i>Chrysothamnus viscidiflorus</i>
0.00	5.00	0.00	0.90	2.21	15.00	<i>Symphoricarpos oreophilus</i>
						FORBS
0.00	0.00	0.00	4.75	6.42	45.00	<i>Achillea millefolium</i>
0.00	0.00	0.00	7.75	12.99	40.00	<i>Aster sp.</i>
0.00	0.00	0.00	0.25	1.09	5.00	<i>Cirsium sp.</i>
0.00	0.00	0.00	0.25	1.09	5.00	<i>Cynoglossum officinale</i>
5.00	0.00	0.00	0.95	2.29	15.00	<i>Lupinus argenteus</i>
5.00	0.00	5.00	0.75	1.79	15.00	<i>Penstemon watsonii</i>
0.00	0.00	0.00	3.75	7.56	25.00	<i>Polygonum aviculare</i>
0.00	0.00	0.00	4.75	10.54	30.00	<i>Taraxacum officinale</i>
						GRASSES
10.00	0.00	5.00	2.25	4.02	30.00	<i>Elymus spicatus</i>
0.00	0.00	0.00	0.75	3.27	5.00	<i>Elymus trachycaulus</i>
0.00	0.00	10.00	8.15	9.51	50.00	<i>Poa pratensis</i>
0.00	0.00	0.00	0.25	1.09	5.00	<i>Poa secunda</i>
						COVER
35.00	70.00	75.00	54.00	11.25		Understory
29.00	25.00	20.00	18.30	9.19		Litter
35.00	4.00	4.00	25.80	15.40		Bareground
1.00	1.00	1.00	1.90	2.21		Rock
						% COMPOSITION
42.86	100.00	73.33	35.06	28.26		Shrubs
28.57	0.00	6.67	42.78	33.08		Forbs
28.57	0.00	20.00	22.16	18.65		Grasses



VEGETATION OF THE  
EMERGENCY GAS VENT HOLES:  
GVH-5B, GVH-07A, GVH-08A  
& REFERENCE AREA  
2006

FOR THE  
CENTENNIAL MINE



INCORPORATED

NOV 21 2006

Div. of Oil, Gas & Mining

*Prepared by*

**MT. NEBO SCIENTIFIC, INC.**  
330 East 400 South, Suite 6  
Springville, Utah 84663  
(801) 489-6937

**Patrick D. Collins, Ph.D.**

*for*

**ANDALEX RESOURCES**  
Centennial Mine  
Post Office Box 902  
Price, Utah 84501



**November 2006**

## TABLE OF CONTENTS

INTRODUCTION .....	1
METHODS .....	2
Photographs .....	3
Sensitive Species .....	3
RESULTS .....	4
GVH-05B .....	4
GVH-07A .....	5
GVH-08A .....	5
Threatened & Endangered Plant Species .....	6
STUDY AREA MAP .....	7
COLOR PHOTOGRAPHS OF THE STUDY AREAS .....	9

## INTRODUCTION

Andalex Resources unexpectedly found it necessary to drill 3 additional boreholes in an emergency situation to vent "gob" gas as a safety procedure prior to mining the areas beneath them. Each drill site will disturb approximately one acre of land, however, the plant communities of two of the sites have been disturbed previously by other activities. The proposed new vent sites have been named and numbered: GVH-5B, GVH-7A, and GVH-8A.

Because this is more of an emergency situation in an attempt to develop more ventilation sites for mine safety conditions, pre-planning was difficult for the mine operator. Consequently, planning and development will be in-between growing seasons, so pre-disturbance collection of quantitative field data of the existing plant communities at the drill sites would have been unreliable.

In the recent past, Mt. Nebo Scientific, Inc. has sampled the vegetation of several other gob gas vent sites prior to the drilling activities necessary for development of them. Drill sites GVH-04, GVH-05A, GVH-07, GVH-08, GVH-09, and the reference areas chosen for revegetation success standards were sampled in the growing season of 2005. Additionally, quantitative data were also recorded for sites GVH-10, GVH-11, GVH-12, GVH-13, GVH-14, GVH-15, GVH-16, and GVH-17 in the growing season of 2006. Appropriate reference areas were also chosen and sampled at that time.

Because of the existing body of work from previous studies associated with the plant communities in the area, representatives from the State of Utah, Division of Oil, Gas & Mining (DOGM) and Andalex Resources met and decided that existing data may be able to represent the proposed new drill sites if so determined beforehand by field visits to them. Accordingly, these site visits were accomplished by biologists from Mt. Nebo Scientific, Inc. and DOGM prior to preparations of this report.

## METHODS

Proposed drill sites were surveyed, mapped, and staked in the field by Andalex prior to the field work performed. As mentioned above, drill sites GVH-5B, GVH-7A, and GVH-8A were visited in the field by biologists from DOGM and Mt. Nebo Scientific, Inc. This work was accomplished on November 7, 2006. At each site, dominant plant species were noted along with general physiognomy of the site. This information was used to correlate the site with similar sites that have been quantitatively sampled previously, or those areas that have been proposed or developed for other gob gas sites including the reference areas chosen for future revegetation standards. The reference areas chosen were approximately one-acre in size and have been marked in the field using a GPS instrument. The coordinates for the proposed GVH drill pads and reference areas are given below. A map showing these locations has been included in this report (see Study Area Map).

**GPS COORDINATES  
FOR CENTENNIAL MINE  
VEGETATION STUDY SITES**

Site Name	Community Type	Waypoint Name	Zone	Easting (m)	Northing (m)
GVH-05B	Sagebrush/Grass	ANGV5B	12S	0523492	4398199
GVH-07A	Sagebrush/Grass	AGV07A	12S	0522404	4398208
GVH-8A	Sagebrush/Grass	AGVH10	12S	0521533	4398202
Sagebrush/Grass Reference Area (lower diversity S/G)	Sagebrush/Grass	AGVHSR	12S	0522309	4398459

**Photographs**

Color photographs of the study areas were taken at the time of the survey and have been submitted with this report.

**Sensitive Species**

To initiate the previous studies in the area, appropriate agencies were consulted and other sources were reviewed (sensitive species files at *Mt. Nebo Scientific, Inc.*) for potential plant species that are known to be rare, endemic, threatened, endangered or otherwise sensitive in the study area.

## RESULTS

Below are the results of the survey for each study site in this report. Locations of these sites are shown on the Study Area Map. Color photographs of each sample site have also been provided in this document.

As mentioned in the INTRODUCTION, *other areas* had been proposed or developed before the emergency drill sites studied and described in this report. Some of these sites would, or already have, impacted very similar Sagebrush/Grass plant communities as those studied here. The earlier drill sites were sampled quantitatively along with their reference areas in the growing seasons of 2005 and 2006. The Sagebrush/Grass Reference Area chosen and sampled in 2006 would be an appropriate standard for final revegetation success for all the emergency sites described herein. Due to the critical time period for approval of the emergency sites, this report was written before completion of the final report of the other 2006 study sites. Consequently, the data set for the 2006 reference area will be submitted later in another report along with other proposed drill sites. Or, more simply stated, the data for the reference area chosen to be used for revegetation standards of the emergency sites in this report will be submitted in another final report.

### GVH-05B

The drill site for GVH-5B is located between two developed gas vent sites, GVH-5 and GVH-5A. Most of the proposed new drill site has been disturbed by roads between the other sites. The



community that existed prior to the disturbance here was Sagebrush/Grass. The new drill site may impact more of this same community on the edges of the current disturbance (see photograph).

The dominant plant species of this site were big sagebrush (*Artemisia tridentata*), Kentucky bluegrass (*Poa pratensis*), and viscid rabbitbrush (*Chrysothamnus viscidiflorus*).

#### GVH-07A

Drill site GVH-7B is located at the exact same location as GVH-7 because this site needs to be drilled again to reopen the ventilation operation. No additional disturbance to the existing plant community will be done to the site (see photograph).

The dominant plant species in this area prior to disturbance were big sagebrush, viscid rabbitbrush, Kentucky bluegrass and bluebunch wheatgrass (*Elymus spicatus*).

#### GVH-08A

The drill site for GVH-8A is the only site in the emergency drilling program that is proposed to disturb a plant community that has had no previous disturbance. This community is another Sagebrush/Grass type (see photograph). Similar plant species as mentioned above for the other sites also dominate this site.

### Threatened & Endangered Plant Species

No rare, endemic, threatened or endangered or otherwise sensitive plant species have been found in any of the previous studies in the same plant communities as the proposed new emergency sites, nor is there habitat at the new sites for the plant species that could potentially occur in the area.

## STUDY AREA MAP

◦ DEADMAN CANYON, UT

◦ 7.5 Minute Series Quadrangle Map

UNITED STATES  
DEPARTMENT OF THE INTERIOR  
GEOLOGICAL SURVEY

110°45'  
39°45'

522000m.E. R 10 E R 11 E

523

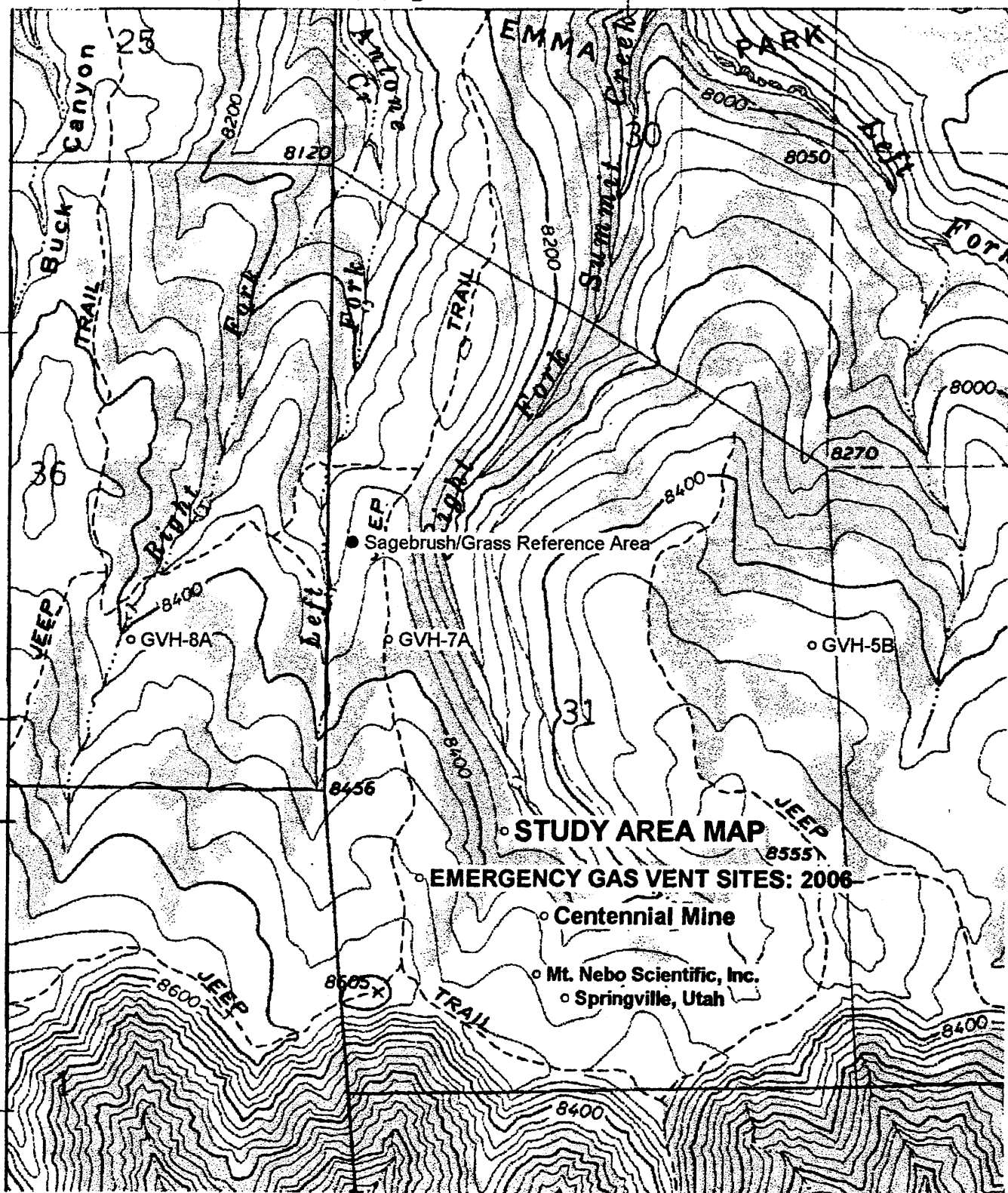
4399000m.N.

4398

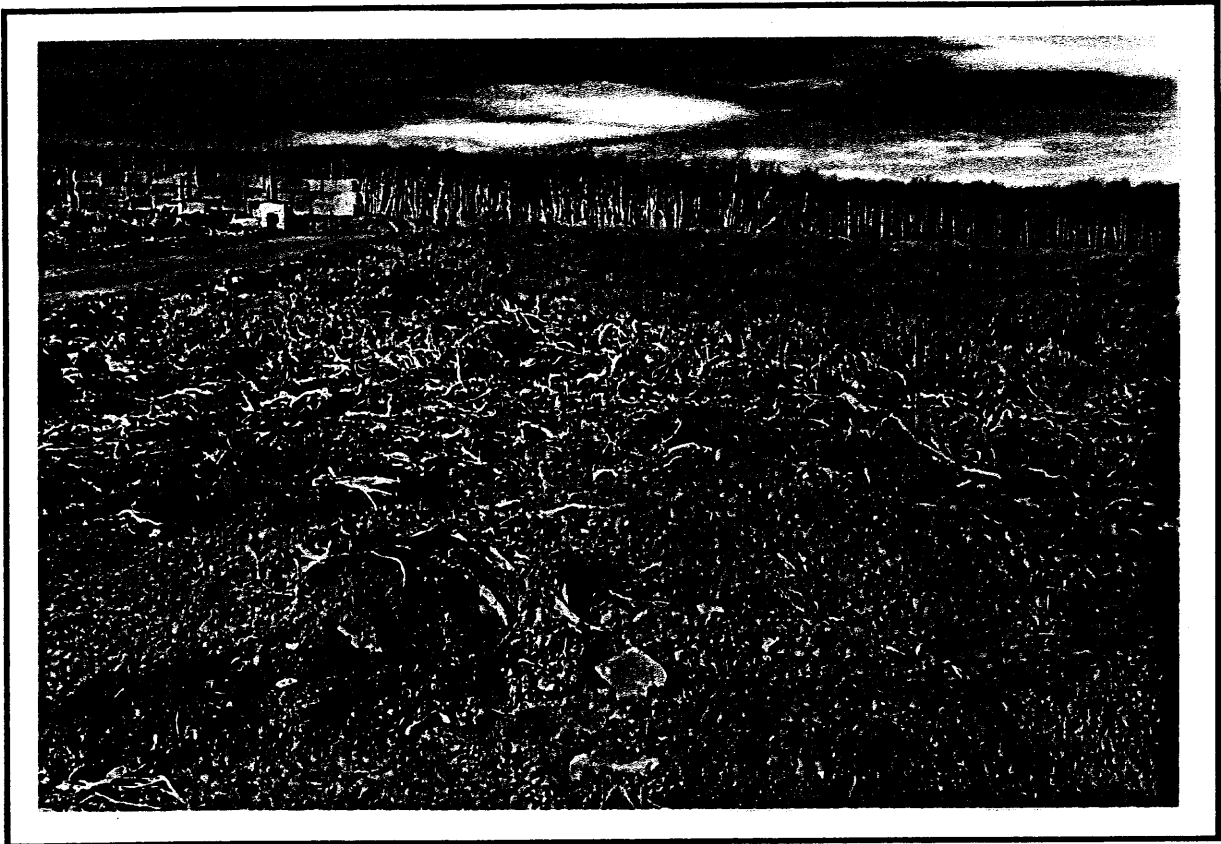
T 12 S

T 13 S

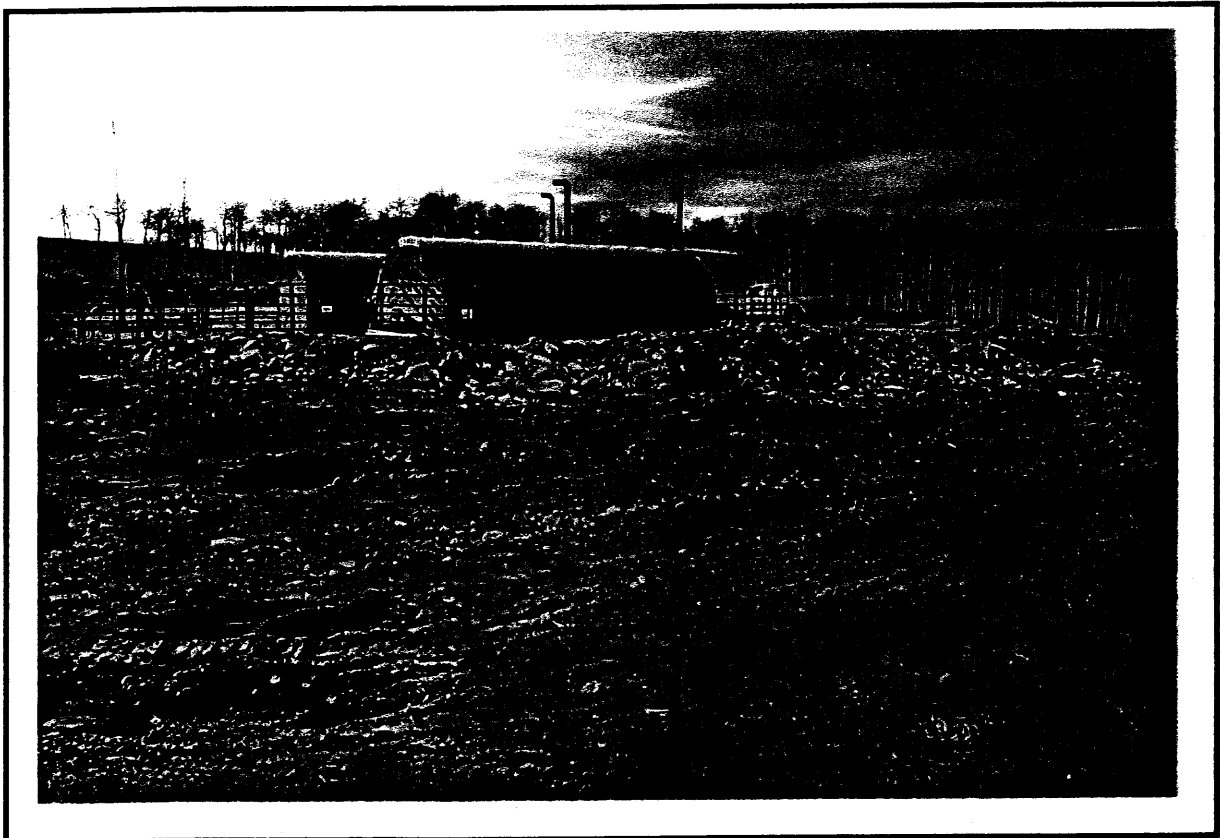
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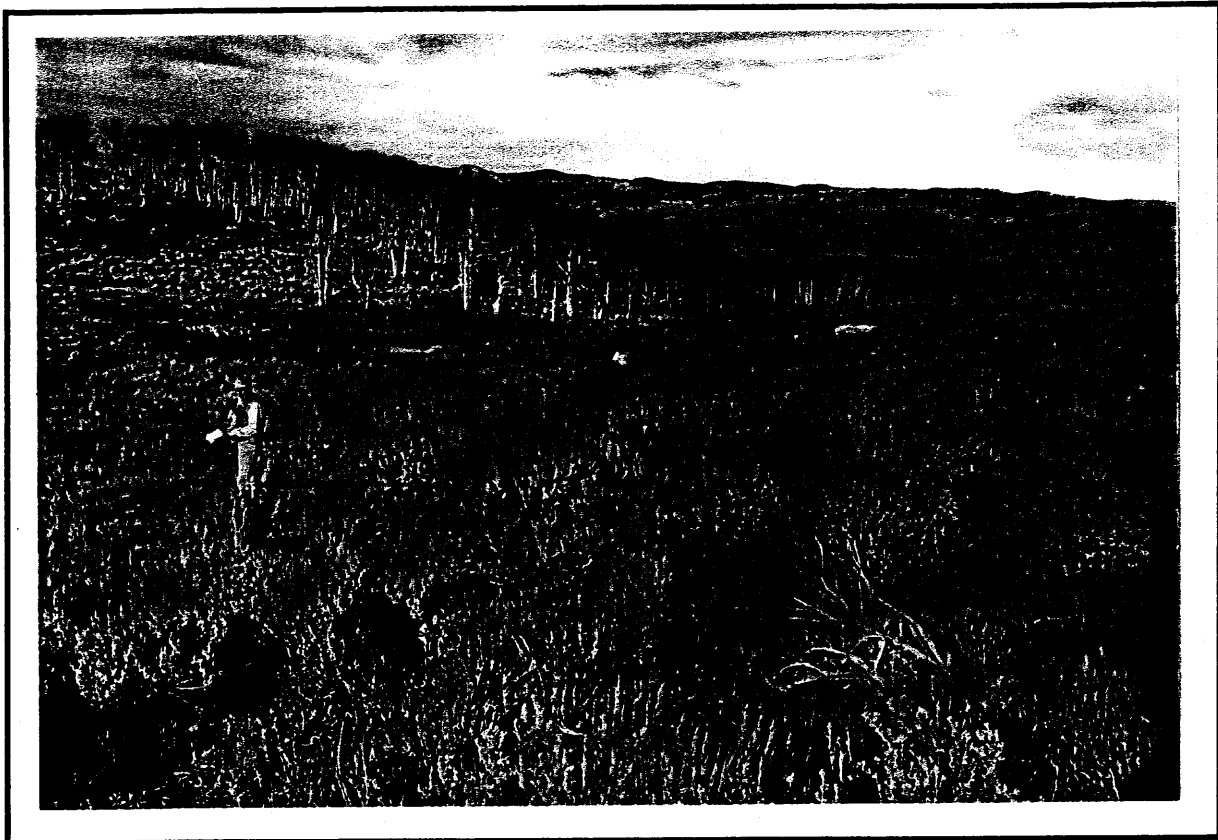
COLOR PHOTOGRAPHS  
OF THE  
STUDY AREAS



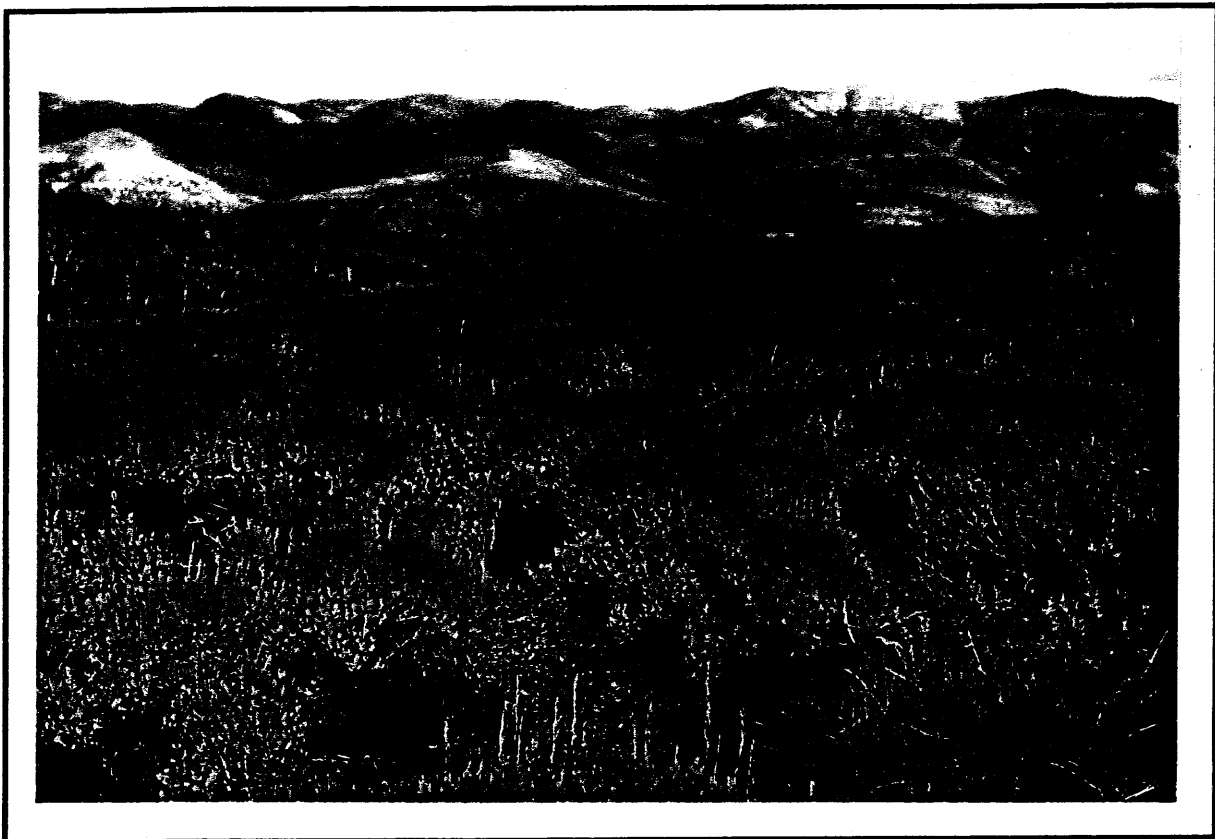
GVH-05B



GVH-07A



GVH-08A



Sagebrush/Grass Reference Area



**ATTACHMENT 3-1  
VEGETATION INVENTORY  
NRCS LETTER**

**ATTACHMENT 3-2**  
**THREATENED, ENDANGERED, AND SENSITIVE SPECIES INFORMATION**

# EIS ENVIRONMENTAL & ENGINEERING CONSULTING

31 North Main Street \* Helper, Utah 84526  
Office - (435) 472-3814 \* Fax - (435) 472-8780 \* Toll free - (800) 641-2927  
eisec@preciscom.net \* www.eisenviro.com

January 17, 2006

Blackhawk Engineering, Inc.  
Mr. Dan Guy  
1056 West 2060 North  
Helper, Utah 84526

RE: Mexican Spotted Owl Habitat : Andalex Proposed Project Area.

Dear Mr. Guy:

Please find attached a map showing suitable habitat for the Mexican Spotted Owl (MSO) in regards to your proposed project area.

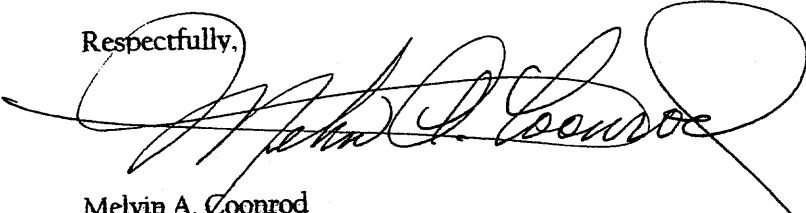
A Memorandum from the Utah Field Supervisor of the USFWS, dated November 21, 2002 states that:

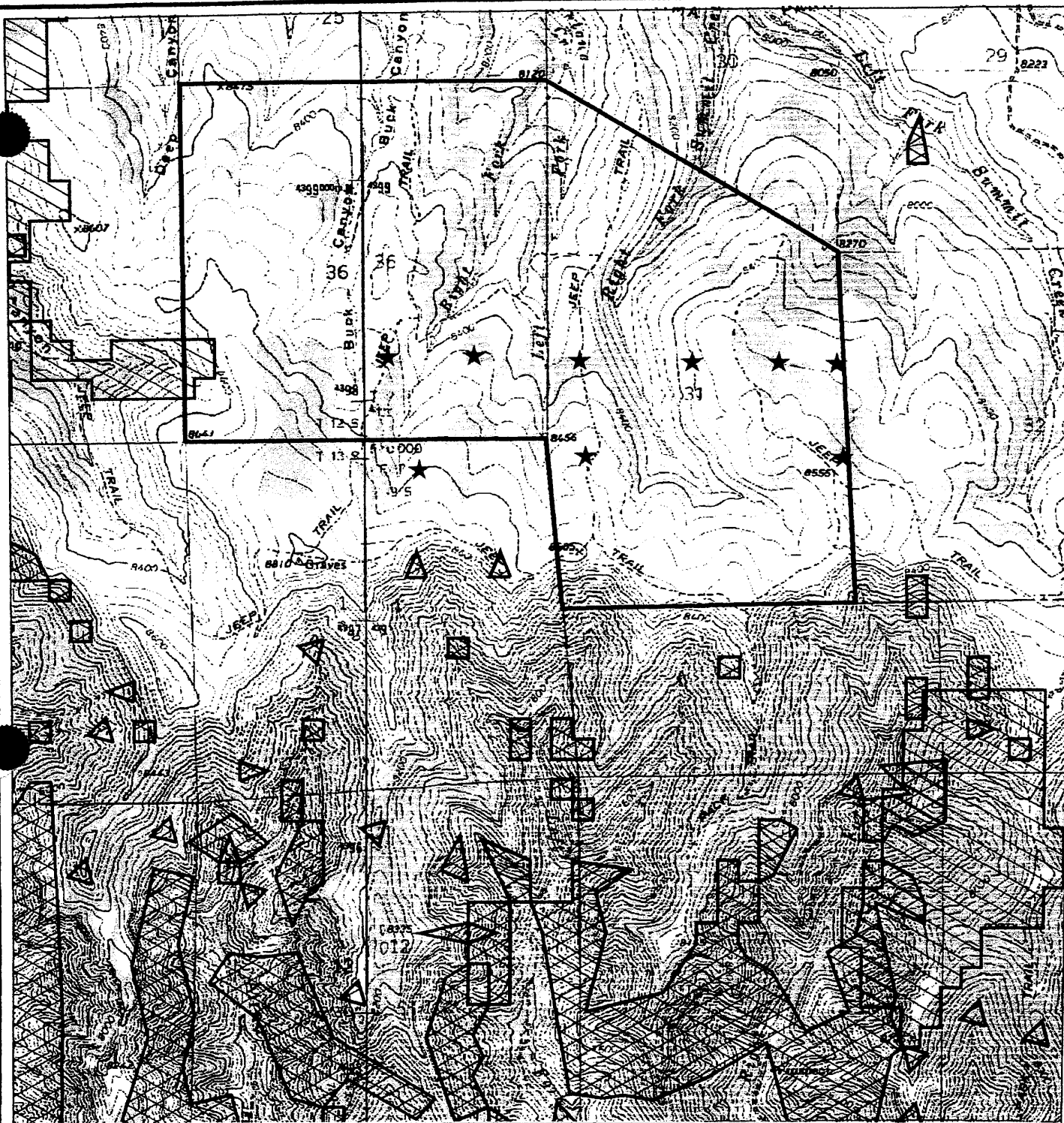
1. "The 1997 model should be used as a first-cut analysis tool to identify potentially rugged areas that may provide suitable owl habitats..."
2. "The 2000 model predicts the location of breeding and roosting habitat within rugged canyon habitat..."
3. "Buffers should be applied to the 2000 model, as follows, and used when evaluating potential project impacts..."
  - a. A 0.5-mile radius should buffer all pixels, including isolated pixels. Habitat within this radius should be evaluated and surveyed for owls, according to protocol.
  - b. Implement the '2X2 Rule', any canyon habitat where the canyon is less than 2 km wide and at least 2 km long should be considered and managed as Protected Habitat. Canyons meeting the 2X2 Rule should also be assessed for the need for owl surveys."

A general consensus of opinion indicated the MSO nesting sites are normally located on the steeper slopes, at mid-canyon levels below 8,000 ft in elevation. The area of proposed disturbance would approach the maximum limit in elevation where MSOs have been located. Based on the 1997 and 2000 habitat models, there is no suitable nesting habitat within this area (Plate I). On January 13, 2006, Mr. Melvin A Coonrod of EIS visited and surveyed the area in question. Mr. Coonrod found that no nesting and/or roosting MSO habitat is located within the project area. Based on this information, it would be reasonable to conclude that surveys in this area are not warranted.

If you have any questions or concerns, please feel free to call (435) 472-3814.

Respectfully,

  
Melvin A. Coonrod  
Owner/Principle Consultant  
EIS Environmental & Engineering Consulting



## LEGEND

- |  |                       |  |                     |
|--|-----------------------|--|---------------------|
|  | Proposed Project Area |  | Proposed Vent Holes |
|  | 1997 Model            |  | Existing            |
|  | 2000 Model            |  | Proposed            |

**Environmental  
Industrial  
Services**  
Environmental & Engineering Consulting

31 North Main Street  
Helper, Utah 84526  
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Fax (435) 472-8780  
eisecc@preciscom.net



## ANDALEX RESOURCES, INC.

PROPOSED VENT HOLES  
Section 36 : T. 12 S., R. 10 E. §  
Section 31 : T. 12 S., R. 11 E.

**Proposed Project Area**  
Mexican Spotted Owl Suitable Habitat  
CREATED ON: 01-17-2006

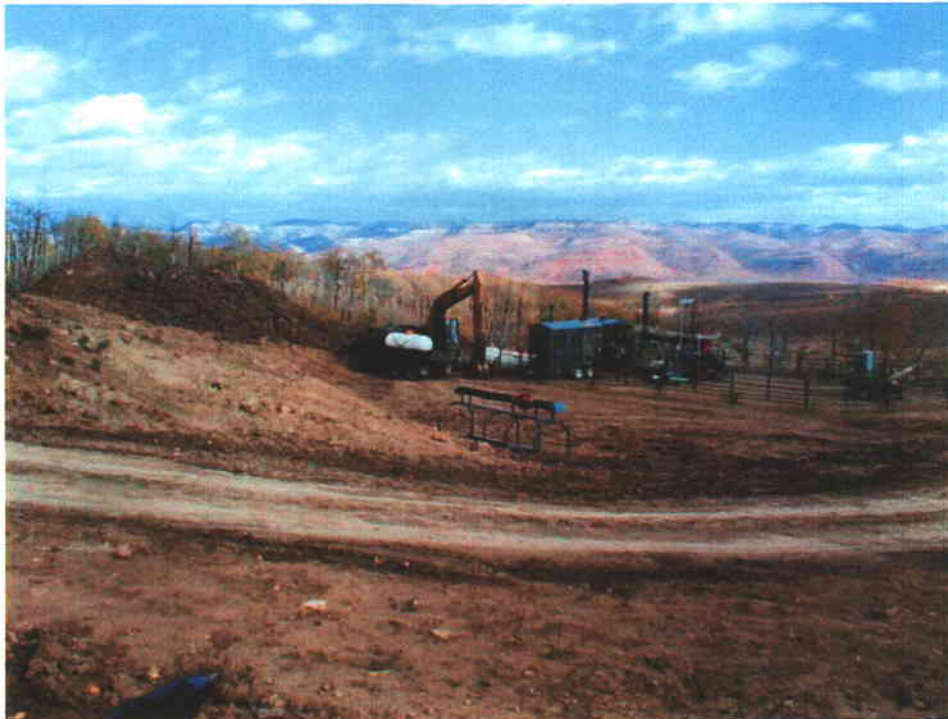
SCALE: 1:2,000 | DRAWN BY: KJN | REVISED: MM-DD-YY

PLATE

1

**ATTACHMENT 3-3**  
**2005 RAPTOR SURVEY**  
**(Relocated to Confidential Binder)**

**ATTACHMENT 3-4**  
**PHOTOS OF GVH SITES**



GVH-1  
ACCESS ROAD

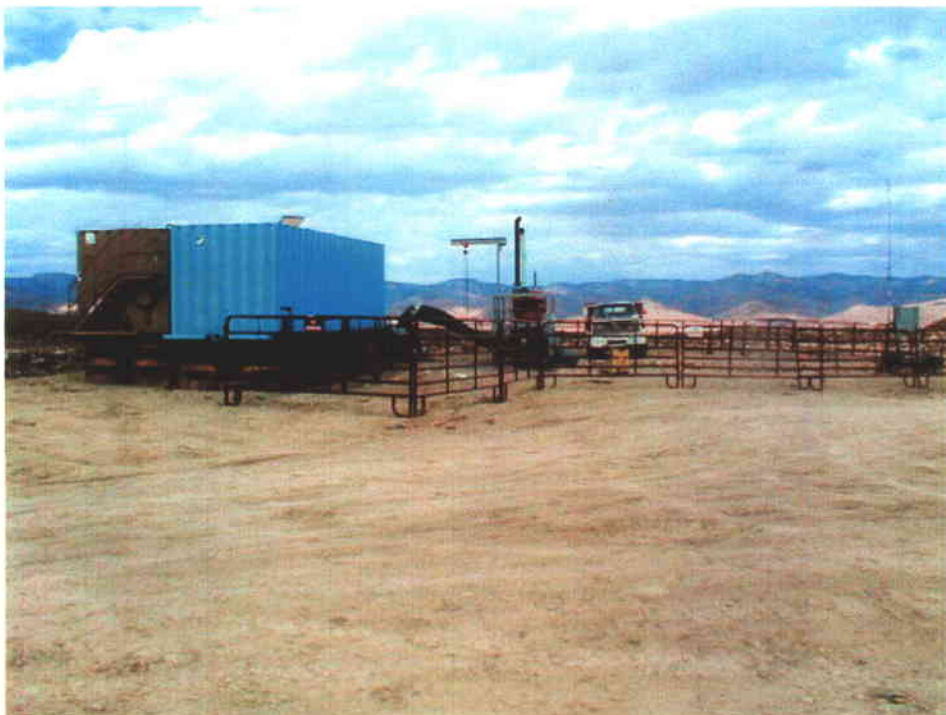


GVH-1  
SITE





GVH-3  
ACCESS ROAD



GVH-3  
SITE



GVH-04



GVH-04 Access Road



GVH-4  
ACCESS ROAD



GVH-4  
SITE





GVH-5  
SITE



GVH-5  
TOPSOIL/RECLAIMED AREA



GVH-6  
SITE



GVH-6  
RECLAIMED AREA





GVH-05A



GVH-07





GVH-08



GVH-09



**ATTACHMENT 3-5  
VEGETATION INVENTORY  
PROPOSED HOLES GVH-11 through GVH-17**

VEGETATION OF THE GAS VENT HOLES:  
GVH-10, GVH-11, GVH-12, GVH-13,  
GVH-14, GVH-15, GVH-16, GVH-17 &  
REFERENCE AREAS  
2006

FOR THE  
CENTENNIAL MINE



*Prepared by*

*MT. NEBO SCIENTIFIC, INC.*  
330 East 400 South, Suite 6  
Springville, Utah 84663  
(801) 489-6937

Patrick D. Collins, Ph.D.

*for*

*ANDALEX RESOURCES*  
Centennial Mine  
Post Office Box 902  
Price, Utah 84501

February 2007



## TABLE OF CONTENTS

INTRODUCTION .....	1
METHODS .....	1
Sampling Design and Transect/Quadrat Placement .....	2
Cover and Composition .....	3
Woody Species Density .....	3
Sample Size & Adequacy .....	3
Statistical Analyses .....	4
Photographs .....	4
Threatened & Endangered Plant Species .....	4
RESULTS .....	5
GVH-10 .....	5
GVH-11 .....	6
GVH-12 .....	7
GVH-12 (Access Road) .....	7
GVH-13 .....	8
GVH-14 .....	8
GVH-15 .....	9
GVH-16 .....	9
GVH-17 .....	10
Aspen/Snowberry/Grass Reference Area (Climax) .....	10
Aspen/Grass Reference Area (Seral) .....	11
Sagebrush/Grass Reference Area .....	12
Threatened & Endangered Plant Species Survey .....	12
SUMMARY & DISCUSSION .....	13
DATA SUMMARY TABLES .....	15
FIGURES .....	31
MAP OF VEGETATION SAMPLE AREAS .....	33
COLOR PHOTOGRAPHS .....	34

## INTRODUCTION

As a safety procedure prior to mining the areas beneath them, boreholes at strategic locations to vent "gob" gas has been proposed by Andalex Resources. The drilling activities will necessitate disturbing about one acre of the vegetation at each drill site. The purpose of this document is to summarize the findings of quantitative sampling in the plant communities proposed for disturbance along with "reference areas" chosen for future revegetation success standards. A sensitive species survey was also conducted on each site proposed for disturbance.

## METHODS

Methodologies used for this study were performed in accordance with the guidelines supplied by the State of Utah, Division of Oil, Gas and Mining (DOGM). Quantitative and qualitative data were taken on the vegetation of the areas proposed for disturbance and their respective reference areas between June 1 and September 15, 2006.

Proposed drill sites were surveyed, mapped and staked in the field by Andalex Resources prior to the field work performed for the vegetation surveys. The reference areas chosen were approximately one-acre in size and were marked in the field using a GPS instrument. The coordinates for the proposed GVH drill pads and reference areas are given below. A map showing these locations has been included in this report (see 2006 Vegetation Sample Areas).

**GPS COORDINATES  
FOR CENTENNIAL MINE  
VEGETATION SAMPLE SITES (2006)**

Site Name	Waypoint Name	Zone	Easting	Northing	Notes
GVH-10	AGVH10	12S	0523554	4398661	Aspen/Snowberry/Grass Community (climax).
GVH-11	AGVH11	12S	0523309	4398655	Aspen/Snowberry/Grass Community (seral).
GVH-12	AGVH12	12S	0523011	4398654	Aspen/Snowberry/Grass Community (seral).
GVH-12 (access)	n/a	n/a	n/a	n/a	Sagebrush/Grass Community; Access road to GVH-12
GVH-13	AGVH13	12S	0522686	4398654	Aspen/Snowberry/Grass Community (seral).
GVH-14	AGVH14	12S	0522362	4398653	Sagebrush/Grass Community.
GVH-15	AGVH15	12S	0522038	4398652	Sagebrush/Grass Community.
GVH-16	AGVH16	12S	0521713	4398651	Aspen/Snowberry/Grass Community (seral).
GVH-17	AGVH17	12S	0521389	4398650	Sagebrush/Grass Community.
Aspen/Grass Reference Area	AGVH9R	12S	0522002	4398050	More <i>seral community</i> ; chosen for GVH-11, GVH-12, GVH-13 & GVH-16 (also for previous GVH-08).
Aspen/Snowberry/Grass Reference Area	AASGRF	12S	0523643	4398549	Closer to a <i>climax community</i> ; chosen for GVH-10.
Sagebrush/Grass Reference Area	AGVHSR	12S	0522309	4398459	Chosen for GVH-14, GVH-15 & GVH-17.

Sampling Design and Transect/Quadrat Placement

Transect lines for vegetation sampling were placed randomly within the boundaries of the proposed disturbed and reference areas. The sample boundaries included 100 ft outside the proposed drill sites. The transect placement technique was employed with the goal to adequately sample a representative subset of the entire site as a whole. Once the transects were established, quadrat locations for sampling were chosen using random numbers from the transect lines with the objective to record data without preconceived bias.



### Cover and Composition

Cover estimates were made using ocular methods with meter square quadrats. Species composition, cover by species, and relative frequencies were also assessed from the quadrats. Additional information recorded on the raw data sheets were: estimated precipitation, slope, exposure, grazing use, animal disturbance and other appropriate notes. Plant nomenclature follows "A Utah Flora" (Welsh et al., 2003).

### Woody Species Density

Density of woody plant species for the proposed disturbed and reference areas were estimated using the point-quarter method. In this method, random points were placed on the sample sites and measured into four quarters. The distances to the nearest woody plant species were then recorded in each quarter. The average point-to-individual distance was equal to the square root of the mean area per individual. The number of individuals per acre was the end results of the calculations.

### Sample Size & Adequacy

Sampling adequacy for cover and density was attempted by using the formula given below.

$$n_{MIN} = \frac{t^2 s^2}{(dx)^2}$$

where,

$n_{MIN}$	= minimum adequate sample
$t$	= appropriate confidence t-value
$s$	= standard deviation
$\bar{x}$	= sample mean
$d$	= desired change from mean

With the values used for “t” and “d” above, the goal was to meet sample adequacy with 80% confidence within a 10% deviation from the true mean.

### Statistical Analyses

Student’s t-tests were employed to compare the total living cover and total woody species density of each proposed disturbed borehole site with its respective reference area.

### Photographs

Color photographs of the sample areas were taken at the time of sampling and have been submitted with this report.

### Threatened & Endangered Plant Species

Prior to recording quantitative data on the plant communities, a sensitive plant species survey was conducted. To initiate the study, appropriate agencies were consulted and other sources were reviewed (sensitive species files at *Mt. Nebo Scientific, Inc.*) for potential plant species that are

known to be rare, endemic, threatened, endangered or otherwise sensitive in the study area.

## RESULTS

Below are the results from sampling each vegetation study site for this report. Locations of these sites are shown on the Vegetation Sample Areas map. Color photographs of each sample site have also been provided later in this document.

### GVH-10

The vegetation of this drill site was that of an aspen/snowberry/grass community. Different from other aspen communities of the area, this community appeared to be more of a "climax" community rather than one of a more "seral" state of succession.

Table 1 shows the percent cover of each of the plant species encountered in the sample quadrats at the GVH-10 site. The dominant plant species in this area were aspen (*Populus tremuloides*), Kentucky bluegrass (*Poa pratensis*), and common dandelion (*Taraxacum officinale*).

The total living cover (overstory plus understory) for this aspen/snowberry/grass community was estimated at 104.65%, 66.50% of which was from understory cover (Table 2-A). Forb species dominated the understory composition comprising 46.15% of the total living cover, followed by grasses at 32.61%, then trees and shrubs at 21.24% (Table 2-B). Woody species density in this

community was estimated at 1,525 individuals per acre (Table 3) and was dominated by aspen and snowberry (*Symphoricarpos oreophilus*).

#### GVH-11

Drill pad site GVH-11 was another aspen community, but much different than the community described for GVH-10 above. GVH-11 appeared to be less of a climax community and more of one in a "seral" successional stage. Accordingly, with this community, and similar communities described later, a different reference area was chosen to represent it for future success standards. The plants in this area seemed to have been affected by some environmental stress conditions such as the recent droughts of Utah, possibly in conjunction with grazing pressures. As explained in a previous report from sampling in 2005, many of the aspen trees showed stress with some of the older trees dead or dying, but there seemed to be rejuvenation occurring by saplings present in these clonal communities probably due to the recent increase in the precipitation patterns of the area.

The dominant plant species of this site were snowberry and Kentucky bluegrass (Table 4). The total living cover including overstory at this site was 75.50% (Table 5-A). Trees and shrubs dominated the composition constituting 52.38% of the total living cover, followed by grasses at 36.33%, then forbs at 11.29% (Table 5-B). The woody species density for GVH-11 was estimated at 7,093 individuals per acre and was dominated by a wide margin by snowberry (Table 6).

## GVH-12

This proposed drill site supported another aspen/grass plant community, much like the one just described above. The dominant plant species in the cover data as shown on Table 7 were Kentucky bluegrass, snowberry, and aspen. The total living cover of GVH-12 was estimated at 76.50%; 65.00% of this was understory and 11.50% was overstory (Table 8-A). Trees and shrubs again dominated the composition of this site where they represented 44.00% of the total living cover, followed closely by grasses at 36.40%, then forbs at 19.61% (Table 8-B). The woody species density of this site was estimated at 5,820 plants per acre (Table 9) which was dominated by snowberry, viscid rabbitbrush, and big sagebrush (*Artemisia tridentata*).

## GVH-12 (Access Road)

Because access to proposed drill pad was so different with respect to the plant community, the proposed access road was sampled separately. This sample area supported a sagebrush/grass plant community type where scattered serviceberry (*Amelanchier utahensis*) shrubs were common.

The most common species by cover and frequency were sagebrush, viscid rabbitbrush, and Kentucky bluegrass (Table 10). The total living cover was estimated at 66.25% (Table 11-A). The cover composition breakdown consisted of 63.93% shrubs, 24.26% grasses, and 11.81%

forbs (Table 11-B). Total woody species density was 8,675 plants per acre and was dominated by big sagebrush, viscid rabbitbrush, and snowberry (Table 12).

### GVH-13

Once again, the proposed drill site here was located within a aspen/snowberry/grass plant community and was dominated by those species of the community name (Table 13). The total combined living cover including both overstory and understory cover was 77.25%, 62.25% of which was understory and 15.00% was overstory cover (Table 14-A).

Table 14-B shows that the cover composition consisted of nearly equal parts of trees and shrubs (38.85%), grasses (33.57%), and forbs (27.58%). Total woody species density of the site was 4,573 individuals per acre and was again dominated by snowberry, viscid rabbitbrush, and big sagebrush (Table 15).

### GVH-14

Proposed drill site GVH-14 was a sagebrush/grass community. The dominant plant species with nearly equal representation was big sagebrush, viscid rabbitbrush, and Kentucky bluegrass (Table 16). The total living cover was estimated at 60.25% (Table 17-A) of which was represented by shrubs comprising 58.34%, grasses at 25.99%, and forbs at 15.67% (Table 17-B).



The woody species density total was 8,993 individuals per acre and consisted mostly of viscid rabbitbrush and big sagebrush, and to a less extent, snowberry (Table 18).

#### GVH-15

Drill site GVH-15 and the access road to it was once again within a sagebrush/grass plant community, and like the previously described community, the site was dominated by big sagebrush, Kentucky bluegrass and viscid rabbitbrush (Table 19). The mean total living cover of the quadrats placed on the access road and drill pad was estimated at 58.25% (Table 20-A). The lifeform composition is shown on Table 20-B; the understory was divided into shrubs (63.79%), grasses (24.80%), and forbs (11.41%).

For density, the total number of woody plants per acre was 8,145 and consisted of big sagebrush, viscid rabbitbrush, snowberry, and Utah serviceberry (Table 21).

#### GVH-16

This drill site was within another aspen/snowberry/grass plant community. The dominant species were similar to other communities of this type and was comprised of Kentucky bluegrass, big sagebrush, and aspen as the most common plants (Table 22). The total living cover (overstory plus understory) was estimated at 66.00%, most of which was understory cover at 61.75%. (Table 23-A). As one would expect, trees and shrubs dominated the composition and comprised 46.87% of the understory cover, followed by grasses at 32.77% and forbs at 20.36% (Table 23-

B).

The woody species density measurements included the following species: big sagebrush, viscid rabbitbrush, snowberry, and aspen. The total number of individuals per acre was 4,201 (Table 24).

#### GVH-17

The final proposed drill site for this study was within a sagebrush/grass community. The dominant species in this area were once again big sagebrush, viscid rabbitbrush, and Kentucky bluegrass, all of which has cover values that were reasonably close to each other (Table 25). The total living cover in this area was 63.75% (Table 26-A). The lifeform proportions of the living cover ended up as 65.88% shrubs, 20.85% grasses, and 13.27% forbs (Table 26-B).

The woody species density measurements showed the following species in descending order of importance: viscid rabbitbrush, big sagebrush, Wood's rose (*Rosa woodsii*), and snowberry. The total number of plants per acre in this area was 8,916 (Table 27).

#### Aspen/Snowberry/Grass Reference Area (Climax)

A aspen/snowberry/grass community that was closer to being in a more *climax stage of ecological succession* was chosen as a reference area for a similar aspen/snowberry/grass

community, or the proposed drill site GVH-10 (see Vegetation Sample Areas map). This community had an overstory cover of aspen at 52.00% (Table 28), and a total living cover that included overstory and understory of 110.75% (Table 29-A). Overstory and understory covers were nearly equally represented (Table 29). Dominant understory species were snowberry, Kentucky bluegrass, dandelion, and aspen (Table 28).

The total living understory cover in this community was 58.75% (Table 29-A). Forbs dominated the understory cover composition, comprising 40.80% of it, whereas shrubs and grasses were represented at 35.96% and 23.24%, respectively (Table 29-B). The total woody species density was estimated at 4,845 individuals per acre and was dominated by snowberry and aspen (Table 30).

#### Aspen/Grass Reference Area (Seral)

An aspen/grass reference area was chosen for future standards that was closer to those proposed disturbed plant communities of the same type in a more *seral stage of succession*, or proposed drill sites: GVH-11, GVH-12, GVH-13, and GVH-16 (see Vegetation Sample Areas map). This community was sampled in 2005 for a similar proposed disturbed community drill site (GVH-08). It had an overstory cover of only aspens at 24.25%. Dominant understory species were snowberry, lupine (*Lupinus argenteus*), Kentucky bluegrass, and aspen (Table 31). The total living understory cover in this community was 52.00%, while the total combined overstory and understory cover was 76.25% (Table 32-A). Trees and shrubs dominated the cover composition

at 58.95%, whereas forbs and grasses were nearly equally represented at 20.79% and 20.26%, respectively (Table 32-B). The total woody species density was estimated at 3,702 individuals per acre and was dominated by snowberry, broom snakeweed (*Gutierrezia sarothrae*) and aspen (Table 33).

#### Sagebrush/Grass Reference Area

A native, undisturbed sagebrush/grass plant community was chosen to represent future revegetation success standards for those sites that had been proposed for disturbance and also supported this same community type (GVH-14, GVH-15, GVH-17).

The dominant plant species of this reference area by cover and frequency were big sagebrush and Kentucky bluegrass (Table 34). This reference area has a total living cover estimated at 61.75% (Table 35-A). Within this total living cover measurement, 63.36% of was from shrubs, 26.70% from grasses, and 9.94% were from forbs (Table 35-B). Woody species density was estimated at 6335 individuals per acre and was comprised of big sagebrush, viscid rabbitbrush, snowberry, and Wood's rose (Table 36).

#### Threatened & Endangered Plant Species Survey

Each proposed disturbed area was surveyed in the field for canyon vetch (or any other threatened, endangered, unusual, rare or sensitive plants). This survey was done prior to recording the

quantitative data used to describe the major plant communities of the study areas. In addition, more searching for sensitive species was done during quantitative sampling of the areas.

State databases revealed only one potential sensitive species to be located in the vicinity of the proposed disturbed borehole sites. This plant was canyon vetch (*Hedysarum occidentale* var. *canone*). No rare, endemic, threatened or endangered or otherwise sensitive species were found in the study areas.

## SUMMARY & DISCUSSION

The plant communities that would be impacted by construction of the proposed drill pads to vent "gob" gas have been sampled (GVH-10 through GVH-16). Additionally, reference areas chosen to represent future revegetation success standards have also been sampled. Sampling results have been summarized and provided in this report.

Total living cover and woody species density values of the proposed disturbed plant communities have been compared statistically with those plant communities of the reference areas. The differences for the **total living cover** values were statistically non-significant in nearly all comparisons (Figure 1). The one exception was the access road to GVH-12, which just barely missed being considered "non-significant" in a two-tailed Student's t-test. When **woody species density** values of the vegetation at the proposed disturbed drill sites were compared with their respective reference areas, many of the differences *were* statistically significant (Figure 2).

To conclude, the total living cover of each of proposed disturbed areas were very similar to their reference areas. Additionally, when the summary tables were reviewed, the species present at the compared sites were very similar, also suggesting that the reference areas may be appropriate for final revegetation success standards. However, because woody species density numbers were dissimilar in the comparisons, as an alternative, a reasonable solution would be to establish a value for this parameter (i.e. 2,000 woody plants per acre) as the success standard. This method has been used for other disturbed areas to formulate success standards for woody species densities. The density value proposed for this parameter should be reviewed by biologists from the State of Utah, Division of Oil, Gas & Mining and Division of Wildlife Resources, as well as the property owners. The value chosen should also meet the desired goals for the post-disturbance land use — that of wildlife habitat and grazing of domestic livestock.

**Table 1: Centennial Mine. Living Cover and Frequency by Plant Species (2006).**

Site: GVH-10			
Community: Aspen/Snowberry/Grass			
	Mean Percent	Standard Deviation	Percent Frequency
<b>OVERSTORY</b>			
<i>Populus tremuloides</i>	38.15	23.85	85.00
<b>UNDERSTORY</b>			
<b>TREES &amp; SHRUBS</b>			
<i>Chrysothamnus nauseosus</i>	0.50	2.18	5.00
<i>Populus tremuloides</i>	3.25	5.76	25.00
<i>Rosa woodsii</i>	0.50	1.50	10.00
<i>Symphoricarpos oreophilus</i>	8.75	12.03	50.00
<b>FORBS</b>			
<i>Achillea millefolium</i>	4.85	4.79	65.00
<i>Astragalus sp.</i>	0.25	1.09	5.00
<i>Cirsium sp.</i>	0.25	1.09	10.00
<i>Collinsia parviflora</i>	0.90	1.84	20.00
<i>Cynoglossum officinale</i>	1.25	3.11	15.00
<i>Delphinium nelsonii</i>	0.50	2.18	5.00
<i>Fragaria vesca</i>	0.50	1.50	10.00
<i>Galium biflorum</i>	0.50	2.18	5.00
<i>Geranium viscosissimum</i>	0.25	1.09	5.00
<i>Lupinus argenteus</i>	0.75	1.79	15.00
<i>Osmorhiza depauperata</i>	0.50	1.50	10.00
<i>Phlox longifolia</i>	0.25	1.09	5.00
<i>Ranunculus cymbalaria</i>	0.25	1.09	5.00
<i>Taraxacum officinale</i>	14.00	7.52	100.00
<i>Thalictrum fendleri</i>	0.75	2.38	10.00
<i>Viola adunca</i>	4.85	3.93	75.00
<b>GRASSES</b>			
<i>Carex sp.</i>	0.25	1.09	5.00
<i>Elymus trachycaulus</i>	4.90	5.26	50.00
<i>Festuca thurberi</i>	0.25	1.09	5.00
<i>Poa pratensis</i>	14.75	16.77	55.00
<i>Poa secunda</i>	2.00	6.78	10.00
<i>Stipa nelsonii</i>	0.75	3.27	5.00



**Table 2: Centennial Mine . Total Cover and Composition (2006).**

Site: GVH-10		
Community: Aspen/Snowberry/Grass		
<b>A. TOTAL COVER</b>		
Overstory	38.15	23.85
Understory	66.50	11.84
Litter	28.15	12.49
Bareground	4.35	3.37
Rock	1.00	0.00
Overstory + Understory	104.65	18.22
<b>B. % COMPOSITION</b>		
Trees & Shrubs	21.24	20.09
Forbs	46.15	12.94
Grasses	32.61	19.76

**Table 3: Centennial Mine . Woody Species Density (2006).**

Site: GVH-10	
Community: Aspen/Snowberry/Grass	
<b>SPECIES</b>	<b>Individuals Per Acre</b>
<i>Artemisia tridentata</i>	
<i>Chrysothamnus nauseosus</i>	57.17
<i>Populus tremuloides</i>	419.26
<i>Rosa woodsii</i>	76.23
<i>Symphoricarpos oreophilus</i>	971.91
<b>TOTAL</b>	<b>1524.56</b>

**Table 4: Centennial Mine . Living Cover and Frequency by Plant Species (2006).**

Site: GVH-11			
Community: Aspen/Snowberry/Grass			
	Mean Percent	Standard Deviation	Percent Frequency
<b>OVERSTORY</b>			
<i>Populus tremuloides</i>	8.50	15.66	30.00
<b>UNDERSTORY</b>			
<b>TREES &amp; SHRUBS</b>			
<i>Amelanchier utahensis</i>	0.50	2.18	5.00
<i>Chrysothamnus viscidiflorus</i>	7.50	13.92	30.00
<i>Populus tremuloides</i>	1.75	5.31	10.00
<i>Rosa woodsii</i>	1.75	4.82	15.00
<i>Symphoricarpos oreophilus</i>	24.00	14.02	90.00
<b>FORBS</b>			
<i>Achillea millefolium</i>	0.50	1.50	10.00
<i>Astragalus sp.</i>	0.25	1.09	5.00
<i>Cynoglossum officinale</i>	2.00	2.92	35.00
<i>Fragaria vesca</i>	0.10	0.44	5.00
<i>Lupinus argenteus</i>	4.50	5.89	45.00
<i>Taraxacum officinale</i>	0.15	0.65	5.00
<b>GRASSES</b>			
<i>Bromus carinatus</i>	0.25	1.09	5.00
<i>Elymus trachycaulus</i>	1.00	3.00	95.00
<i>Poa pratensis</i>	22.75	10.54	10.00

**Table 5: Centennial Mine . Total Cover and Composition (2006).**

Site: GVH-II		
Community: Aspen/Snowberry/Grass		
<b>A. TOTAL COVER</b>		
Overstory	8.50	15.66
Understory	67.00	8.12
Litter	22.35	8.82
Bareground	9.35	9.85
Rock	1.30	0.71
Overstory + Understory	75.50	14.04
<b>B. % COMPOSITION</b>		
Trees & Shrubs	52.38	16.17
Forbs	11.29	8.70
Grasses	36.33	15.76

**Table 6: Centennial Mine . Woody Species Density (2006).**

Site: GVH-II	
Community: Aspen/Snowberry/Grass	
<b>SPECIES</b>	<b>Individuals Per Acre</b>
<i>Artemisia tridentata</i>	88.66
<i>Chrysothamnus viscidiflorus</i>	709.28
<i>Populus tremuloides</i>	265.98
<i>Rosa woodsii</i>	265.98
<i>Symphoricarpos oreophilus</i>	5762.89
<b>TOTAL</b>	<b>7092.79</b>

**Table 7: Centennial Mine . Living Cover and Frequency by Plant Species (2006).**

Site: GVH-12			
Community: Aspen/Snowberry/Grass			
	Mean Percent	Standard Deviation	Percent Frequency
<b>OVERSTORY</b>			
<i>Populus tremuloides</i>	11.50	17.97	35.00
<b>UNDERSTORY</b>			
<b>TREES &amp; SHRUBS</b>			
<i>Artemisia tridentata</i>	1.60	4.60	15.00
<i>Chrysothamnus nauseosus</i>	1.50	4.50	10.00
<i>Chrysothamnus viscidiflorus</i>	7.65	10.05	50.00
<i>Populus tremuloides</i>	1.00	3.00	10.00
<i>Symphoricarpos oreophilus</i>	17.00	11.45	80.00
<b>FORBS</b>			
<i>Achillea millefolium</i>	2.00	3.67	25.00
<i>Cynoglossum officinale</i>	1.75	3.27	25.00
<i>Fragaria vesca</i>	0.25	1.09	5.00
<i>Lupinus argenteus</i>	8.50	9.10	70.00
<b>GRASSES</b>			
<i>Elymus trachycaulus</i>	2.75	4.60	30.00
<i>Poa pratensis</i>	21.00	13.19	95.00

**Table 8: Centennial Mine . Total Cover and Composition (2006).**

Site: GVH-12		
Community: Aspen/Snowberry/Grass		
<b>A. TOTAL COVER</b>		
Overstory	11.50	17.97
Understory	65.00	9.22
Litter	23.50	8.38
Bareground	10.35	7.16
Rock	1.15	0.36
Overstory + Understory	76.50	14.76
<b>B. % COMPOSITION</b>		
Trees & Shrubs	44.00	17.65
Forbs	19.61	13.66
Grasses	36.40	17.12

**Table 9: Centennial Mine . Woody Species Density (2006).**

Site: GVH-12	
Community: Aspen/Snowberry/Grass	
<b>SPECIES</b>	<b>Individuals Per Acre</b>
<i>Artemisia tridentata</i>	654.70
<i>Chrysothamnus nauseosus</i>	72.74
<i>Chrysothamnus viscidiflorus</i>	1673.13
<i>Populus tremuloides</i>	363.72
<i>Rosa woodsii</i>	145.49
<i>Symphoricarpos oreophilus</i>	2909.78
<b>TOTAL</b>	<b>5819.57</b>

**Table 10: Centennial Mine . Living Cover and Frequency by Plant Species (2006).**

Site: Access Road to GVH-12			
Community: Sagebrush/Grass/Scattered Serviceberry			
	Mean Percent	Standard Deviation	Percent Frequency
<b>TREES &amp; SHRUBS</b>			
<i>Amelanchier utahensis</i>	0.50	2.18	5.00
<i>Artemisia tridentata</i>	23.75	15.24	90.00
<i>Chrysothamnus viscidiflorus</i>	15.00	10.25	85.00
<i>Rosa woodsii</i>	0.50	2.18	5.00
<i>Symphoricarpos oreophilus</i>	2.75	4.02	35.00
<b>FORBS</b>			
<i>Achillea millefolium</i>	1.25	4.44	10.00
<i>Lupinus argenteus</i>	6.25	8.04	45.00
<i>Penstemon watsonii</i>	0.25	1.09	5.00
<b>GRASSES</b>			
<i>Elymus trachycaulus</i>	2.00	3.67	25.00
<i>Poa pratensis</i>	14.00	8.31	90.00

**Table 11: Centennial Mine . Total Cover and Composition (2006).**

Site: Access Road to GVH-12			
Community: Sagebrush/Grass/Scattered Serviceberry			
<b>A. TOTAL COVER</b>			
Understory	66.25	5.67	
Litter	22.75	7.33	
Bareground	8.50	4.60	
Rock	2.50	3.19	
<b>B. % COMPOSITION</b>			
Shrubs	63.93	12.57	
Forbs	11.81	12.52	
Grasses	24.26	12.42	

**Table 12: Centennial Mine . Woody Species Density (2006).**

Site: Access Road to GVH-12		
Community: Sagebrush/Grass/Scattered Serviceberry		
SPECIES	Individuals Per Acre	
<i>Amelanchier utahensis</i>	108.44	
<i>Artemisia tridentata</i>	4662.79	
<i>Chrysothamnus viscidiflorus</i>	2385.61	
<i>Rosa woodsii</i>	108.44	
<i>Symphoricarpos oreophilus</i>	1409.68	
<b>TOTAL</b>	<b>8674.95</b>	

**Table 13: Centennial Mine . Living Cover and Frequency by Plant Species (2006).**

Site: GVH-13			
Community: Aspen/Snowberry/Grass			
	Mean Percent	Standard Deviation	Percent Frequency
<b>OVERSTORY</b>			
<i>Populus tremuloides</i>	15.00	15.08	60.00
<b>UNDERSTORY</b>			
<b>TREES &amp; SHRUBS</b>			
<i>Artemisia tridentata</i>	3.75	7.89	25.00
<i>Chrysothamnus nauseosus</i>	0.75	3.27	5.00
<i>Chrysothamnus viscidiflorus</i>	8.00	9.00	50.00
<i>Populus tremuloides</i>	3.50	7.43	25.00
<i>Symphoricarpos oreophilus</i>	8.75	7.73	65.00
<b>FORBS</b>			
<i>Achillea millefolium</i>	4.75	4.32	65.00
<i>Cynoglossum officinale</i>	2.00	2.45	40.00
<i>Lathyrus lanszwertii</i>	0.50	1.50	10.00
<i>Lupinus argenteus</i>	7.50	7.83	65.00
<i>Potentilla concinna</i>	0.25	1.09	5.00
<i>Taraxacum officinale</i>	1.75	2.38	35.00
<b>GRASSES</b>			
<i>Festuca thurberi</i>	1.25	2.68	
<i>Poa pratensis</i>	19.50	10.36	

**Table 14: Centennial Mine . Total Cover and Composition (2006).**

Site: GVH-13			
Community: Aspen/Snowberry/Grass			
<b>A. TOTAL COVER</b>			
Overstory	15.00	15.08	
Understory	62.25	6.80	
Litter	19.25	8.81	
Bareground	16.45	10.46	
Rock	2.05	2.31	
Overstory + Understory	77.25	16.01	
<b>B. % COMPOSITION</b>			
Trees & Shrubs	38.85	19.83	
Forbs	27.58	16.53	
Grasses	33.57	16.86	

**Table 15: Centennial Mine . Woody Species Density (2006).**

Table 15: Centennial Mine - Woody Species	
Site: GVH-13	
Community: Aspen/Snowberry/Grass	
SPECIES	Individuals Per Acre
<i>Artemisia tridentata</i>	457.26
<i>Chrysothamnus nauseosus</i>	57.16
<i>Chrysothamnus viscidiflorus</i>	1314.63
<i>Populus tremuloides</i>	685.89
<i>Symphoricarpos oreophilus</i>	2057.68
TOTAL	4572.62



**Table 16: Centennial Mine . Living Cover and Frequency by Plant Species (2006).**

Site: GVH-14			
Community: Sagebrush/Grass			
	Mean Percent	Standard Deviation	Percent Frequency
<b>TREES &amp; SHRUBS</b>			
<i>Artemisia tridentata</i>	18.00	14.18	75.00
<i>Chrysothamnus viscidiflorus</i>	15.75	8.10	100.00
<i>Symphoricarpos oreophilus</i>	1.75	3.27	25.00
<b>FORBS</b>			
<i>Achillea millefolium</i>	0.50	2.18	5.00
<i>Astragalus sp.</i>	0.25	1.09	5.00
<i>Lupinus argenteus</i>	7.75	8.87	60.00
<i>Penstemon watsonii</i>	0.75	1.79	15.00
<b>GRASSES</b>			
<i>Poa pratensis</i>	15.50	6.87	100.00

**Table 17: Centennial Mine . Total Cover and Composition (2006).**

Site: GVH-14		
Community: Sagebrush/Grass		
<b>A. TOTAL COVER</b>		
Understory	60.25	8.14
Litter	21.65	10.01
Bareground	14.90	10.25
Rock	3.20	1.99
<b>B. % COMPOSITION</b>		
Shrubs	58.34	19.73
Forbs	15.67	19.41
Grasses	25.99	11.27

**Table 18: Centennial Mine . Woody Species Density (2006).**

Site: GVH-14		
Community: Sagebrush/Grass		
<b>SPECIES</b>	<b>Individuals Per Acre</b>	
<i>Artemisia tridentata</i>	3934.36	
<i>Chrysothamnus viscidiflorus</i>	4496.42	
<i>Symphoricarpos oreophilus</i>	562.05	
<b>TOTAL</b>	<b>8992.83</b>	

**Table 19: Centennial Mine . Living Cover and Frequency by Plant Species (2006).**

Site: GVH-15 E+ Access Road			
Community: Sagebrush/Grass			
	Mean Percent	Standard Deviation	Percent Frequency
<b>TREES &amp; SHRUBS</b>			
<i>Amelanchier utahensis</i>	2.00	6.78	10.00
<i>Artemisia tridentata</i>	20.00	12.94	85.00
<i>Chrysothamnus viscidiflorus</i>	9.75	8.29	75.00
<i>Symphoricarpos oreophilus</i>	5.75	4.82	65.00
<b>FORBS</b>			
<i>Astragalus sp.</i>	0.25	1.09	5.00
<i>Lupinus argenteus</i>	5.25	6.42	50.00
<i>Penstemon watsonii</i>	1.00	2.00	20.00
<b>GRASSES</b>			
<i>Elymus trachycaulus</i>	0.25	1.09	5.00
<i>Poa pratensis</i>	14.00	5.83	100.00

**Table 20: Centennial Mine . Total Cover and Composition (2006).**

Site: GVH-15 E+ Access Road		
Community: Sagebrush/Grass		
<b>A. TOTAL COVER</b>		
Understory	58.25	9.12
Litter	20.45	7.47
Bareground	17.10	12.10
Rock	4.20	3.75
<b>B. % COMPOSITION</b>		
Shrubs	63.79	15.75
Forbs	11.41	12.25
Grasses	24.80	10.37

**Table 21: Centennial Mine . Woody Species Density (2006).**

Site: GVH-15 E+ Access Road	
Community: Sagebrush/Grass	
SPECIES	Individuals Per Acre
<i>Amelanchier utahensis</i>	305.42
<i>Artemisia tridentata</i>	3156.08
<i>Chrysothamnus viscidiflorus</i>	2850.66
<i>Symphoricarpos oreophilus</i>	1832.56
<b>TOTAL</b>	<b>8144.73</b>

**Table 22: Centennial Mine . Living Cover and Frequency by Plant Species (2006).**

Site: GVH-16			
Community: Aspen/Snowberry/Grass			
	Mean Percent	Standard Deviation	Percent Frequency
<b>OVERSTORY</b>			
<i>Populus tremuloides</i>	4.25	13.90	10.00
<b>UNDERSTORY</b>			
<b>TREES &amp; SHRUBS</b>			
<i>Artemisia tridentata</i>	10.25	9.01	75.00
<i>Chrysothamnus viscidiflorus</i>	8.50	9.50	50.00
<i>Populus tremuloides</i>	1.25	5.45	5.00
<i>Symphoricarpos oreophilus</i>	8.75	12.03	50.00
<b>FORBS</b>			
<i>Achillea millefolium</i>	2.50	4.61	25.00
<i>Cynoglossum officinale</i>	2.25	2.49	45.00
<i>Lathyrus lanszwertii</i>	0.25	1.09	5.00
<i>Lupinus argenteus</i>	5.75	7.79	55.00
<i>Taraxacum officinale</i>	1.25	4.44	10.00
<b>GRASSES</b>			
<i>Bromus carinatus</i>	0.25	1.09	5.00
<i>Elymus spicatus</i>	0.75	2.38	10.00
<i>Festuca thurberi</i>	0.50	1.50	10.00
<i>Poa pratensis</i>	19.50	14.22	90.00

**Table 23: Centennial Mine . Total Cover and Composition (2006).**

Site: GVH-16		
Community: Aspen/Snowberry/Grass		
<b>A. TOTAL COVER</b>		
Overstory	4.25	13.90
Understory	61.75	11.54
Litter	22.60	13.33
Bareground	13.95	9.77
Rock	1.70	1.42
Overstory + Understory	66.00	15.13
<b>B. % COMPOSITION</b>		
Trees & Shrubs	46.87	25.83
Forbs	20.36	20.18
Grasses	32.77	17.76

**Table 24: Centennial Mine . Woody Species Density (2006).**

Site: GVH-16	
Community: Aspen/Snowberry/Grass	
SPECIES	Individuals Per Acre
<i>Artemisia tridentata</i>	1942.83
<i>Chrysothamnus viscidiflorus</i>	1417.74
<i>Populus tremuloides</i>	105.02
<i>Symphoricarpos oreophilus</i>	735.12
<b>TOTAL</b>	<b>4200.71</b>

**Table 25: Centennial Mine . Living Cover and Frequency by Plant Species (2006).**

Site: GVH-17			
Community: Sagebrush/Grass			
	Mean Percent	Standard Deviation	Percent Frequency
<b>TREES &amp; SHRUBS</b>			
<i>Artemisia tridentata</i>	19.25	13.99	80.00
<i>Chrysothamnus viscidiflorus</i>	17.00	11.34	90.00
<i>Rosa woodsii</i>	0.50	2.18	5.00
<i>Symphoricarpos oreophilus</i>	5.25	6.61	45.00
<b>FORBS</b>			
<i>Achillea millefolium</i>	0.25	1.09	5.00
<i>Cynoglossum officinale</i>	0.75	2.38	10.00
<i>Lupinus argenteus</i>	6.50	7.43	50.00
<i>Penstemon watsonii</i>	0.25	1.09	5.00
<i>Potentilla concinna</i>	0.50	1.50	10.00
<i>Taraxacum officinale</i>	0.25	1.09	5.00
<b>GRASSES</b>			
<i>Bromus carinatus</i>	0.25	1.09	5.00
<i>Festuca thurberi</i>	0.25	1.09	5.00
<i>Poa pratensis</i>	12.75	6.98	95.00

**Table 26: Centennial Mine . Total Cover and Composition (2006).**

Site: GVH-17		
Community: Sagebrush/Grass		
<b>A. TOTAL COVER</b>		
Understory	63.75	8.04
Litter	22.10	8.63
Bareground	12.60	9.27
Rock	1.55	1.20
<b>B. % COMPOSITION</b>		
Shrubs	65.88	15.67
Forbs	13.27	12.41
Grasses	20.85	11.87

**Table 27: Centennial Mine . Woody Species Density (2006).**

Site: GVH-17	
Community: Sagebrush/Grass	
SPECIES	Individuals Per Acre
<i>Artemisia tridentata</i>	3343.48
<i>Chrysothamnus viscidiflorus</i>	4792.32
<i>Rosa woodsii</i>	557.25
<i>Symphoricarpos oreophilus</i>	222.90
<b>TOTAL</b>	<b>8915.94</b>

**Table 28: Centennial Mine . Living Cover and Frequency by Plant Species (2006).**

Site: Reference Area Community: Aspen/Snowberry/Grass (climax)	Mean Percent	Standard Deviation	Percent Frequency
<b>OVERSTORY</b>			
<i>Populus tremuloides</i>	52.00	23.95	85.00
<b>UNDERSTORY</b>			
<b>TREES &amp; SHRUBS</b>			
<i>Mahonia repens</i>	3.25	4.26	45.00
<i>Pachistima myrsinites</i>	0.50	1.50	10.00
<i>Populus tremuloides</i>	4.00	4.84	45.00
<i>Rosa woodsii</i>	1.25	2.68	20.00
<i>Symphoricarpos oreophilus</i>	12.65	11.59	75.00
<b>FORBS</b>			
<i>Achillea millefolium</i>	1.00	2.00	20.00
<i>Arnica cordifolia</i>	0.60	1.83	10.00
<i>Astragalus sp.</i>	1.50	2.78	25.00
<i>Collinsia parviflora</i>	0.75	1.79	15.00
<i>Cynoglossum officinale</i>	1.25	2.68	20.00
<i>Delphinium nelsonii</i>	0.25	1.09	5.00
<i>Galium biflorum</i>	0.75	1.79	15.00
<i>Lupinus argenteus</i>	1.84	2.91	30.00
<i>Osmorhiza depauperata</i>	3.00	4.00	40.00
<i>Smilacina stellata</i>	1.35	2.15	30.00
<i>Taraxacum officinale</i>	4.75	6.61	55.00
<i>Thalictrum fendleri</i>	2.75	3.70	40.00
<i>Viola adunca</i>	3.40	3.18	60.00
<b>GRASSES</b>			
<i>Elymus trachycaulus</i>	1.75	2.86	30.00
<i>Festuca thurberi</i>	0.75	3.27	5.00
<i>Poa fendleriana</i>	1.75	5.76	10.00
<i>Poa pratensis</i>	7.50	8.44	60.00
<i>Stipa nelsonii</i>	2.25	6.80	10.00

**Table 29: Centennial Mine . Total Cover and Composition (2006).**

Site: Reference Area		
Community: Aspen/Snowberry/Grass (climax)		
<b>A. TOTAL COVER</b>		
Overstory	52.00	23.95
Understory	58.75	10.71
Litter	35.05	9.31
Bareground	5.10	2.70
Rock	1.10	0.30
Overstory + Understory	110.75	24.36
<b>B. % COMPOSITION</b>		
Trees & Shrubs	35.96	16.61
Forbs	40.80	17.90
Grasses	23.24	15.25

**Table 30: Centennial Mine . Woody Species Density (2006).**

Site: Reference Area	
Community: Aspen/Snowberry/Grass (climax)	
<b>SPECIES</b>	<b>Individuals Per Acre</b>
<i>Pachistima myrsinites</i>	60.57
<i>Populus tremuloides</i>	1817.03
<i>Rosa woodsii</i>	545.11
<i>Symphoricarpos oreophilus</i>	2422.71
<b>TOTAL</b>	<b>4845.42</b>

**Table 31: Centennial Mine. Living Cover and Frequency by Plant Species (2005).**

Site: Reference Area	Mean	Standard	Percent
Community: Aspen/Grass (seral)	Percent	Deviation	Frequency
<b>OVERSTORY</b>			
<i>Populus tremuloides</i>	24.25	17.77	75.00
<b>UNDERSTORY</b>			
<b>SHRUBS</b>			
<i>Artemisia tridentata</i>	1.25	3.49	15.00
<i>Chrysothamnus viscidiflorus</i>	6.00	10.07	35.00
<i>Populus tremuloides</i>	6.50	11.84	35.00
<i>Rosa woodsii</i>	4.75	11.01	25.00
<i>Symphoricarpos oreophilus</i>	12.75	17.06	50.00
<b>FORBS</b>			
<i>Achillea millefolium</i>	0.25	1.09	5.00
<i>Cynoglossum officinale</i>	0.25	1.09	5.00
<i>Lupinus argenteus</i>	9.25	6.76	85.00
<b>GRASSES</b>			
<i>Bromus carinatus</i>	0.50	2.18	5.00
<i>Elymus spicatus</i>	1.50	4.50	15.00
<i>Poa pratensis</i>	8.25	13.44	50.00
<i>Stipa columbiana</i>	0.75	1.79	15.00

**Table 32: Centennial Mine. Total Cover and Composition (2005).**

Site: Reference Area	Mean	Standard	Sample
Community: Aspen/Grass (seral)	Percent	Deviation	Size
<b>A. TOTAL COVER</b>			
Overstory	24.25	17.77	20
Understory	52.00	13.55	20
Litter	27.10	14.70	20
Bareground	19.65	18.42	20
Rock	1.25	0.89	20
Overstory + Understory	76.25	18.43	20
<b>B. COMPOSITION</b>			
Trees & Shrubs	58.95	28.06	20
Forbs	20.79	18.28	20
Grasses	20.26	19.17	20

**Table 33: Centennial Mine. Woody Species Density (2005).**

Site: Reference Area	
Community: Aspen/Grass (seral)	
<b>SPECIES</b>	<b>Individuals</b>
	<b>Per Acre</b>
<i>Artemisia tridentata</i>	185.12
<i>Gutierrezia sarothrae</i>	879.32
<i>Populus tremuloides</i>	833.04
<i>Rosa woodsii</i>	462.80
<i>Symphoricarpos oreophilus</i>	1342.12
<b>TOTAL</b>	<b>3702.40</b>



**Table 34: Centennial Mine . Living Cover and Frequency by Plant Species (2006).**

Site: Reference Area			
Community: Sagebrush/Grass			
	Mean Percent	Standard Deviation	Percent Frequency
<b>TREES &amp; SHRUBS</b>			
<i>Amelanchier utahensis</i>	0.50	2.18	5.00
<i>Artemisia tridentata</i>	26.25	13.12	85.00
<i>Chrysothamnus viscidiflorus</i>	9.15	8.70	70.00
<i>Rosa woodsii</i>	0.85	2.59	10.00
<i>Symphoricarpos oreophilus</i>	2.75	5.12	25.00
<b>FORBS</b>			
<i>Achillea millefolium</i>	0.50	2.18	5.00
<i>Astragalus sp.</i>	0.50	1.50	10.00
<i>Lupinus argenteus</i>	3.75	5.89	35.00
<i>Penstemon watsonii</i>	1.00	2.55	15.00
<i>Taraxacum officinale</i>	0.25	1.09	5.00
<b>GRASSES</b>			
<i>Festuca thurberi</i>	0.25	1.09	5.00
<i>Poa pratensis</i>	16.00	8.89	100.00

**Table 35: Centennial Mine . Total Cover and Composition (2006).**

Site: Reference Area		
Community: Sagebrush/Grass		
<b>A. TOTAL COVER</b>		
Understory	61.75	7.79
Litter	16.75	6.18
Bareground	12.90	6.46
Rock	8.60	5.81
<b>B. % COMPOSITION</b>		
Shrubs	63.36	17.55
Forbs	9.94	10.59
Grasses	26.70	14.79

**Table 36: Centennial Mine . Woody Species Density (2006).**

Site: Reference Area	
Community: Sagebrush/Grass	
<b>SPECIES</b>	<b>Individuals Per Acre</b>
<i>Artemisia tridentata</i>	3880.37
<i>Chrysothamnus viscidiflorus</i>	1821.40
<i>Rosa woodsii</i>	237.57
<i>Symphoricarpos oreophilus</i>	395.96
<b>TOTAL</b>	<b>6335.30</b>

**FIG. 1.** A statistical comparison (Student's t-tests) of the **total living cover** between the proposed disturbed GVH sites and their reference areas (2006).

	<u><math>\bar{x}</math></u>	<u>s</u>	<u>n</u>	<u>t</u>	<u>df</u>	<u>SL</u>
<b>GVH-10</b>						
<u>Proposed Disturbed:</u>	104.65	18.22	20			
<u>Reference Area:</u>	110.75	24.36	20			
t-test				-0.897	38	N.S.
<b>GVH-11</b>						
<u>Proposed Disturbed:</u>	75.70	9.81	20			
<u>Reference Area:</u>	76.25	18.43	20			
t-test				-0.118	38	N.S.
<b>GVH-12</b>						
<u>Proposed Disturbed:</u>	76.50	14.76	20			
<u>Reference Area:</u>	76.25	18.43	20			
t-test				-0.131	38	N.S.
<b>GVH-12 (access road)</b>						
<u>Proposed Disturbed:</u>	66.25	5.67	20			
<u>Reference Area:</u>	61.75	7.79	20			
t-test				2.089	38	p<.05
<b>GVH-13</b>						
<u>Proposed Disturbed:</u>	77.25	21.76	20			
<u>Reference Area:</u>	76.25	18.43	20			
t-test				0.157	38	N.S.
<b>GVH-14</b>						
<u>Proposed Disturbed:</u>	60.25	8.14	20			
<u>Reference Area:</u>	61.75	7.79	20			
t-test				-0.595	38	N.S.
<b>GVH-15</b>						
<u>Proposed Disturbed:</u>	58.25	9.12	20			
<u>Reference Area:</u>	61.75	7.79	20			
t-test				1.305	38	N.S.
<b>GVH-16</b>						
<u>Proposed Disturbed:</u>	66.00	15.13	20			
<u>Reference Area:</u>	76.25	18.43	20			
t-test				-1.922	38	N.S.
<b>GVH-17</b>						
<u>Proposed Disturbed:</u>	63.75	8.04	20			
<u>Reference Area:</u>	61.75	7.79	20			
t-test				0.799	38	N.S.

$\bar{x}$  = mean

s = standard deviation

n = sample size

t = Student's t-value

p = probability level

df = degrees of freedom

SL= Significance Level

N.S.= Non-Significant

**FIG. 2.** A statistical comparison (Student's t-tests) of the **woody species density** between the proposed disturbed GVH sites and their reference areas (2006).

	<u><math>\bar{x}</math></u>	<u>s</u>	<u>n</u>	<u>t</u>	<u>df</u>	<u>SL</u>
<b>GVH-10</b>						
<u>Proposed Disturbed:</u>	1524.56	1303.76	20			
<u>Reference Area:</u>	4845.42	4366.43	20			
t-test				-3.259	38	p<.005
<b>GVH-11</b>						
<u>Proposed Disturbed:</u>	7092.79	2803.85	20			
<u>Reference Area:</u>	3702.40	2706.98	20			
t-test				3.890	38	p<.001
<b>GVH-12</b>						
<u>Proposed Disturbed:</u>	5819.57	1351.11	20			
<u>Reference Area:</u>	3702.40	2706.98	20			
t-test				3.130	38	p<.005
<b>GVH-12 (access road)</b>						
<u>Proposed Disturbed:</u>	8674.95	3692.47	20			
<u>Reference Area:</u>	6335.30	2255.84	20			
t-test				2.418	38	p<.05
<b>GVH-13</b>						
<u>Proposed Disturbed:</u>	4572.62	3551.92	20			
<u>Reference Area:</u>	3702.40	2706.98	20			
t-test				0.871	38	N.S.
<b>GVH-14</b>						
<u>Proposed Disturbed:</u>	8992.83	2507.50	20			
<u>Reference Area:</u>	6335.30	2255.84	20			
t-test				3.524	38	p<.005
<b>GVH-15</b>						
<u>Proposed Disturbed:</u>	8144.73	3252.95	20			
<u>Reference Area:</u>	6335.30	2255.84	20			
t-test				2.044	38	p<.05
<b>GVH-16</b>						
<u>Proposed Disturbed:</u>	4200.71	2834.16	20			
<u>Reference Area:</u>	3702.40	2706.98	20			
t-test				0.569	38	N.S.
<b>GVH-17</b>						
<u>Proposed Disturbed:</u>	8915.94	2489.22	20			
<u>Reference Area:</u>	6335.30	2255.84	20			
t-test				3.436	38	p<.005

$\bar{x}$  = mean

s = standard deviation

n = sample size

t = Student's t-value

p = probability level

df = degrees of freedom

SL= Significance Level

N.S.= Non-Significant





COLOR PHOTOGRAPHS  
OF  
SAMPLE AREAS





GVH-10



GVH-11





GVH-12



GVH-12 (access)



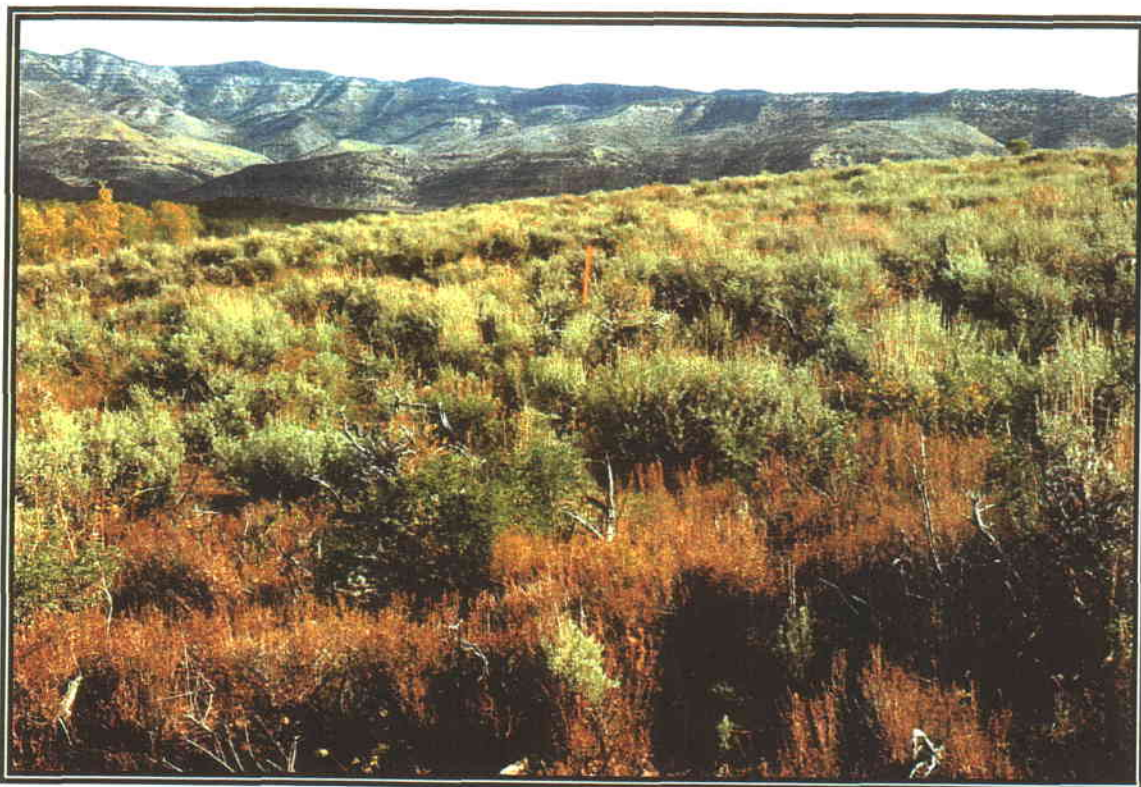


GVH-13



GVH-14





GVH-15



GVH-16





GVH-17



Aspen/Grass Reference Area (seral)





Aspen/Snowberry/Grass Reference Area (climax)



Sagebrush/Grass Reference Area

**VEGETATION DESCRIPTIONS OF THE  
INTERMEDIATE GAS VENT HOLES:  
GVH-10A *through* GVH-16A  
& REFERENCE AREAS  
2006**

**FOR THE  
CENTENNIAL MINE**



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## TABLE OF CONTENTS

INTRODUCTION .....	1
METHODS .....	2
Photographs .....	3
Sensitive Species .....	3
RESULTS .....	4
GVH-10-A .....	4
GVH-11A .....	5
GVH-12A .....	6
GVH-13A .....	6
GVH-14A .....	7
GVH-15A .....	7
GVH-16A .....	8
Threatened & Endangered Plant Species .....	8
STUDY AREA MAP .....	9
COLOR PHOTOGRAPHS OF THE STUDY AREAS .....	11



## INTRODUCTION

In anticipation of finding it necessary to drill additional vent holes to release "gob" gas as a safety procedure prior to underground mining in specific areas, *Andalex Resources* requested information from *Mt. Nebo Scientific, Inc.* about the plant communities that would be impacted in specific areas.

If constructed, each new drill site would disturb approximately one acre of land. The new sites are located between other drill site locations where the vegetation was quantitatively sampled in the growing season of 2006. Because they are between or "intermediate" to other drill sites, the new sites have been named and numbered: GVH-10A through GVH-16A.

Because the decision to consider more drill sites was anticipatory and came too late in the growing season to collect reliable quantitative data from the plant communities that would be impacted, qualitative data were collected instead. However, because *Mt. Nebo Scientific, Inc.* has sampled the vegetation of several other gob gas vent sites and the reference areas associated with them prior to other drilling activities, the plant communities in the area have been well-studied. For this reason, a site visit to each of the intermediate drill sites was conducted in the fall of 2006. Qualitative notes and photographs were taken at that time so that established reference areas could be chosen to represent each site for standards of future final revegetation success.

## METHODS

Proposed drill sites were surveyed and mapped in the field by Andalex prior to the field work performed. Drill sites GVH-10A, GVH-11A, GVH-12A, GVH-13A, GVH-14A, GVH-15A, and GVH-16A were visited in the field by biologists from the *State of Utah, Division of Oil, Gas & Mining* (J. Helfrich) and *Mt. Nebo Scientific, Inc.* (P. Collins). This work was accomplished on November 7, 2006. At each site, dominant plant species were noted along with general physiognomy of the site. This information was used to correlate the site with similar sites that have been quantitatively sampled previously, or those areas that have been proposed or developed for other gob gas sites including the reference areas chosen for future revegetation success standards. The reference areas chosen were approximately one-acre in size and have been marked in the field using a GPS instrument. The coordinates for the proposed drill pads and reference areas are given below. A map showing these locations has been included in this report (see Study Area Map).

**GPS COORDINATES FOR CENTENNIAL MINE:  
INTERMEDIATE DRILL STUDY SITES (2006)**

Site Name	Community Type	Waypoint Name	Zone	Easting (m)	Northing (m)
GVH-10A	Aspen/Snowberry/Grass (climax)	AGV10A	12S	0523497	4398656
GVH-11A	Sagebrush/Grass	AGV11A	12S	0523173	4398655
GVH-12A	Aspen/Snowberry/Grass (seral)	AGV12A	12S	0522848	4398654
GVH-13A	Sagebrush/Grass	AGV13A	12S	0522524	4398653
GVH-14A	Sagebrush/Grass	AGV14A	12S	0522200	4398652
GVH-15A	Aspen/Snowberry/Grass (seral)	AGV15A	12S	0521876	4398651
GVH-16A	Sagebrush/Grass	AGV16A	12A	0521551	4398650
Reference Area	Aspen/Snowberry/Grass (climax)	AASGRF	12S	0523643	4398549
Reference Area	Aspen/Grass (seral)	AGVH9R	12S	0522002	4398050
Reference Area	Sagebrush/Grass (lower diversity S/G)	AGVHSR	12S	0522309	4398459

Photographs

Color photographs of the study areas were taken at the time of the survey and have been submitted with this report.

Sensitive Species

To initiate the previous studies in the area, appropriate agencies were consulted and other sources were reviewed (sensitive species files at *Mt. Nebo Scientific, Inc.*) for potential plant species that are known to be rare, endemic, threatened, endangered or otherwise sensitive in the study area.

## RESULTS

Below are the results of the survey for each study site in this report. Locations of these sites are shown on the Study Area Map. Color photographs of each sample site have also been provided in this document.

As mentioned in the INTRODUCTION, *other drill sites* have been proposed or developed prior to the intermediate drill sites studied and described for this report. Some of these sites would, or already have, impacted very similar plant communities as those studied here. The earlier drill sites were sampled quantitatively along with their reference areas in the growing seasons of 2005 and 2006. The reference areas chosen and sampled in 2005 and 2006 would also be appropriate standards for final revegetation success for intermediate sites described herein.

### GVH-10-A

The drill site for GVH-10A is located between two developed gas vent sites, GVH-10 and GVH-11. This site is very similar to GVH-10, which was sampled quantitatively in 2006 with the results submitted in the report to Andalex called: *VEGETATION OF THE GAS VENT HOLES: GVH-10, GVH-11, GVH-12, GVH-13, GVH-14, GVH-15, GVH-16, GVH-17 & REFERENCE AREAS: 2006*.

The vegetation at this drill site was that of an aspen/snowberry/grass community (see COLOR

PHOTOGRAPHS OF STUDY AREAS). In contrast to other aspen communities of the area, this community appeared to be more of a "climax" community rather than one of a more "seral" state of succession. The dominant plant species in this area were aspen (*Populus tremuloides*), Kentucky bluegrass (*Poa pratensis*), and common dandelion (*Taraxacum officinale*).

A reference area was chosen and sampled during the same time period as the sampling for GVH-10. The sample area was called the **Aspen/Snowberry/Grass (Climax) Reference Area**.

Similar plant species dominated this reference area and GVH-10A (see COLOR PHOTOGRAPHS OF STUDY AREAS). This same reference area would be an appropriate area to be used as success standards for final revegetation success for GVH-10A.

#### GVH-11A

Drill site GVH-11A supports the same plant community as sampled previously for: GVH-12 (Access Road) (described in the aforementioned 2006 study). The plant community here was a sagebrush/grass community type where scattered serviceberry (*Amelanchier utahensis*) shrubs were common. The most common species were sagebrush (*Artemisia tridentata*), viscid rabbitbrush (*Chrysothamnus nauseosus*), and Kentucky bluegrass (*Poa pratensis*).

The reference area chosen for this community was called the **Sagebrush/Grass Reference Area** (see COLOR PHOTOGRAPHS OF STUDY AREAS and STUDY AREA MAP).

## GVH-12A

The vegetation at drill site for GVH-12A was an aspen/snowberry/grass community and was very similar to the vegetation at GVH-13, and also the reference area chosen for that site (see COLOR PHOTOGRAPHS ). The site was dominated by those species in the community name.

An **Aspen/Grass Reference Area** was chosen for future standards that was closer to a *seral stage of ecological succession* compared to the aspen/snowberry/grass community described above (see STUDY AREA MAP). Dominant understory species were snowberry (*Symphoricarpos oreophilus*), lupine (*Lupinus argenteus*), Kentucky bluegrass, and aspen. This community was sampled and described in the previously mentioned 2006 report.

## GVH-13A

The GPS coordinates provided by Andalex for this proposed drill site placed the proposed drill pad within an aspen/snowberry/grass community where scattered serviceberry were also common. This drill pad was also on a sloped area. It was considered more likely from the observers perspective that the drill site would ultimately be located about 100 ft from this site in a more level and easily accessible area. If so, the plant community impacted in this case would be that of a sagebrush/grass community much like that described above for GVH-11A. Therefore the reference area chosen for standard of this area was the **Sagebrush/Grass Reference Area**. If the more sloped area ends up being the site of the drill pad, the **Aspen/Grass (Seral) Reference**



Area could be used for future standards of revegetation success.

#### GVH-14A

This site was another sagebrush/grass community with the dominate species comprising of big sagebrush, viscid rabbitbrush, and Kentucky bluegrass. Somewhat unlike the previously studied sagebrush/grass communities, it has more open areas that were comprised more of forb and grass species with fewer sagebrush plants (see COLOR PHOTOGRAPHS ). Nonetheless, the consensus of the observers was that the **Sagebrush/Grass Reference Area** previously sampled and described would be an appropriate standard for revegetation success.

#### GVH-15A

The vegetation at this drill site was an aspen/snowberry/grass community. Like the previous described community in GVH-12A, and in contrast to other aspen communities of the area, this community appeared to be more of a "seral" community rather than one of a more "climax" state of succession (see COLOR PHOTOGRAPHS OF STUDY AREAS). The dominant plant species in this area were aspen, viscid rabbitbrush, sagebrush, and Kentucky bluegrass.

An **Aspen/Grass Reference Area** was chosen for future standards that was closer to a *seral* stage. Dominant understory species were snowberry, lupine, Kentucky bluegrass, and aspen. As mentioned above, this community was sampled and described in the previously mentioned 2006

report.

#### GVH-16A

Like GVH-11A, GVH-13A, and GVH-14 described above, this site was another sagebrush/grass community with the dominate species comprising of big sagebrush, viscid rabbitbrush, and Kentucky bluegrass (see COLOR PHOTOGRAPHS OF SAMPLE AREAS). Therefore, the **Sagebrush Grass Reference Area** previously sampled and described would be an appropriate standard for revegetation success.

#### Threatened & Endangered Plant Species

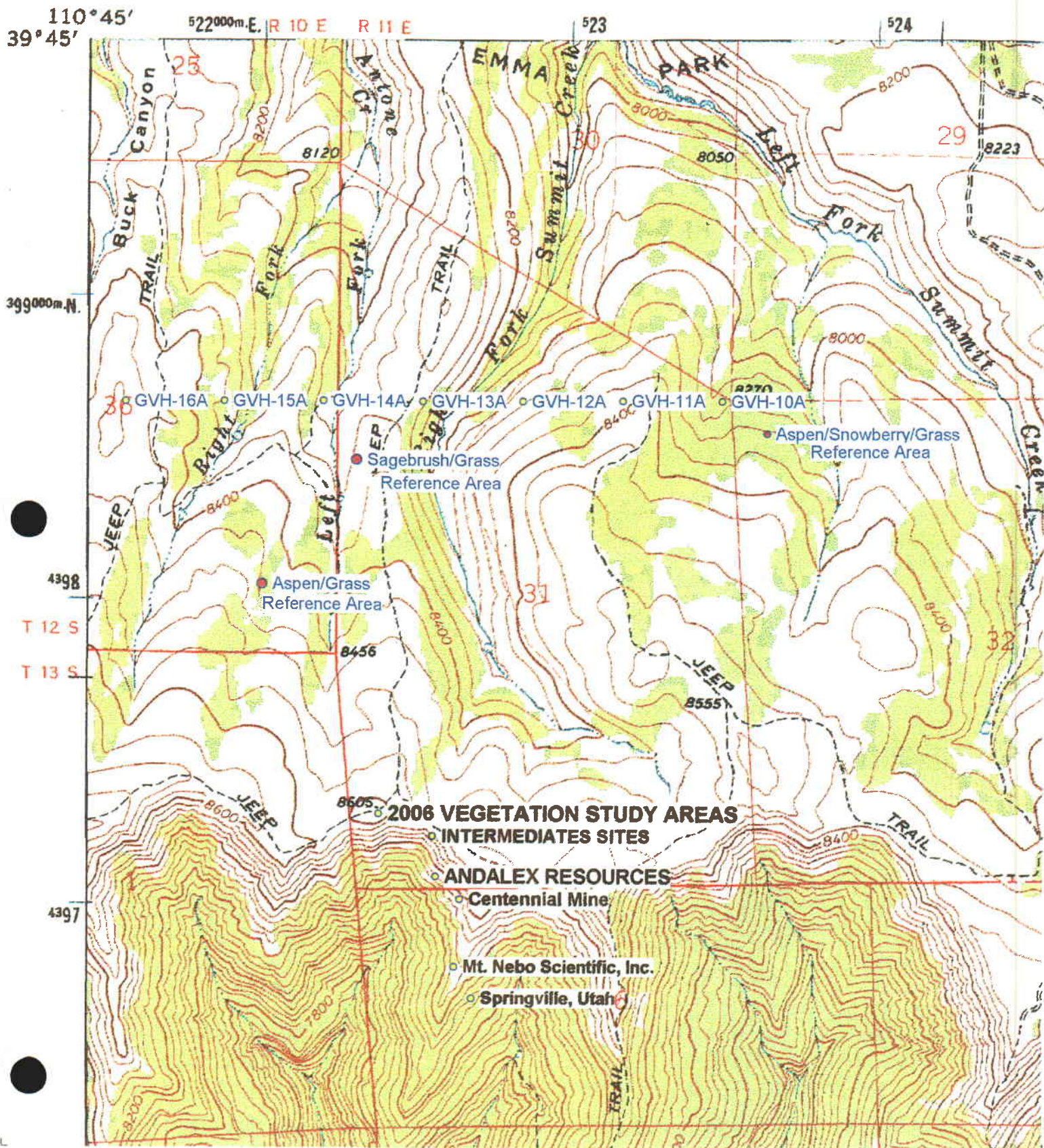
No rare, endemic, threatened or endangered or otherwise sensitive plant species have been found in any of the previous studies in the same plant communities as the proposed new intermediate sites, nor is there habitat at the new sites for the plant species that could potentially occur in the area.

## STUDY AREA MAP



DEADMAN CANYON, UT  
7.5 Minute Series Quadrangle Map

UNITED STATES  
DEPARTMENT OF THE INTERIOR  
GEOLOGICAL SURVEY



**COLOR PHOTOGRAPHS  
OF THE  
STUDY AREAS**





GVH-10A



GVH-11A





GVH-12A



GVH-13A





GVH-14A



GVH-15A





GVH-16A



Aspen/Snowberry/Grass Reference Area (climax)





Aspen/Grass Reference Area (seral)



Sagebrush/Grass Reference Area

(Revised)  
FEBRUARY 2007

**CHAPTER 4**  
**LAND USE AND AIR QUALITY**

## TABLE OF CONTENTS

<u>Section</u>	<u>Page</u>
<b>410 LAND USE</b> .....	<b>4-1</b>
<b>411 Environmental Description</b> .....	<b>4-1</b>
411.100 Premining Land Use .....	4-1
411.110 Land Use Map and Narrative .....	4-1
411.120 Land Capacity .....	4-1
411.130 Land Use Description .....	4-1
411.140 Cultural and Historic Resources Information .....	4-1
411.200 Previous Mining Activity .....	4-2
<b>412 Reclamation Plan</b> .....	<b>4-2</b>
412.100 Postmining Land-Use Plan .....	4-2
412.200 Land Owner or Surface Manager Comments .....	4-2
<b>413 Performance Standards</b> .....	<b>4-3</b>
413.100 Postmining Land Use .....	4-3
413.200 Determining Premining Uses of Land .....	4-3
413.300 Criteria for Alternative Postmining Land Uses .....	4-3
<b>414 Alternate Land Use</b> .....	<b>4-3</b>
<b>420 AIR QUALITY</b> .....	<b>4-3</b>
<b>421 Air Quality</b> .....	<b>4-3</b>
<b>422 Compliance Efforts</b> .....	<b>4-3</b>
<b>423 Monitoring Program</b> .....	<b>4-3</b>
<b>424 Fugitive Dust Control Plan</b> .....	<b>4-3</b>
<b>425 Additional Division Requirements</b> .....	<b>4-3</b>



## **LIST OF ATTACHMENTS**

- Attachment 4-1** Cultural Resource Survey and Inventory - Approved holes GVH-1 through GVH-9.
- Attachment 4-2** Surface Land Owner Notification (Moved to Confidential Binder)
- Attachment 4-3** Cultural Resource Survey and Inventory - Proposed Holes GVH-10 through GVH-17

## **410 LAND USE**

### **411 Environmental Description**

A statement of the conditions and capabilities of the land to be affected by mining and reclamation operations follows in this section.

#### **411.100 Premining Land Use**

The area is utilized for the landowners private use, including hunting and as open range for livestock and wildlife.

#### **411.110 Land Use Map and Narrative**

Refer to the same section of the approved M&RP.

#### **411.120 Land Capability**

The major plant communities at the well sites are identified in Section 321. No cultivated lands lie within the well boundaries, due to the limiting terrain and lack of water for irrigation. Refer to Section 321.200, of this submittal for forage production per acre for each well site.

#### **411.130 Land Use Description**

The wells are located on land administered by Dave R. & Mildred Cave, et al., and Mathis Land, Inc. and zoned by Carbon County for mining and grazing (MG-1).

No industrial or municipal facilities are located on or immediately adjacent to the well sites.

#### **411.140 Cultural and Historic Resources Information**

For Gob Gas Holes 1, 3, 4, 5 and 6, preliminary research and file search has been conducted by Senco-Phenix of Price, Utah and the research indicates that there is a very low probability of the occurrence of cultural resources at the proposed drill sites. Senco-Phenix has also completed a Cultural Resource Survey of the approved sites GVH#5A, GVH#7, GVH#8 and GVH#9, as well as approved sites GVH#5B and GVH #8A. (GVH #7A was a re-drill on the existing disturbed pad of GVH #7, which as been previously surveyed for archeological resources.) Due to required changes in the mining plan, hole GVH#5B will not be drilled and has been shown as eliminated, although the site has been approved and included in the bonding. Results of these surveys are included in Attachment 4-1 "Cultural Resources Survey and Inventory - Approved Holes GVH-1 through GVH-9".

A total of 15 additional well sites are proposed with this submittal - GVH#10, GVH#10A, GVH#11, GVH#11A, GVH#12, GVH#12A, GVH#13, GVH#13A, GVH#14, GVH#14A,

GVH#15, GVH#15A, GVH#16, GVH#16A, GVH#17. Each of the proposed hole locations (GVH#10 through GVH#17) along with access corridors, has had an intensive cultural resource survey and inventory completed on them. The results of these surveys are included in Attachment 4-3 - "Cultural Resource Survey and Inventory - Proposed Holes GVH-10 through GVH-17".

It should be noted that all sites had findings of "No Effect" and all were recommended for Archaeological Clearance.

Andalex Resources, Inc. agrees to notify the Division and State Historical Preservation Office (SHPO) of previously unidentified cultural resources discovered in the course of operations. Andalex also agrees to have any such cultural resources evaluated in terms of NRHP eligibility criteria. Protection of eligible cultural resources will be in accordance with Division and SHPO requirements. Andalex will also instruct its employees that it is a violation of federal and state law to collect individual artifacts or to otherwise disturb cultural resources.

#### **411.200 Previous Mining Activity**

Andalex Resource, Inc. has no knowledge of the removal of coal or other minerals in the well site areas.

### **412 Reclamation Plan**

#### **412.100 Postmining Land-Use Plan**

All uses of the land prior to the wells construction/operation and the capacity of the land to support prior alternate uses will remain available throughout the life of the sites.

Andalex Resource, Inc. intends the postmining land use to be livestock and wildlife grazing and other uses as indicated by the land owner (hunting, etc.). Final reclamation activities will be completed in a manner to provide the lands to parallel the premining land use.

#### **412.200 Land Owner or Surface Manager Comments**

Surface lands are owned by Dave R. & Mildred Cave, et al., and Mathis Land, Inc. Appropriate landowner approvals have been obtained for the proposed wells. Required notification of drilling will be sent to the landowners prior to start. Copies of the notification letters have been included in Attachment 4-2.

## **413 Performance Standards**

### **413.100 Postmining Land Use**

Postmining land uses are discussed in Section 412.100. The postmining lands will be reclaimed in a timely manner and capable of supporting such uses (see Chapters 2, 3, 5 and 7).

### **413.200 Determining Premining Uses of Land**

Refer to Section 411.100.

### **413.300 Criteria for Alternative Postmining Land Use**

No alternative postmining land uses have been planned.

## **414 Alternative Land Use**

No alternative postmining land uses have been planned.

## **420 AIR QUALITY**

### **421 Air Quality Standards**

Gob gas vent hole activities will be conducted in compliance with the requirements of the Federal Clean Air Act and the Utah Air Conservation Rules.

### **422 Compliance Efforts**

See Fugitive Dust Control Plan, Section 424.

### **423 Monitoring Program**

Refer to the same section in the approved M&RP.

### **424 Fugitive Dust Control Plan**

Operational areas that are used by mobile equipment will be water sprayed to control fugitive dust. The application of water will be of sufficient frequency and quantity to maintain the surface material in a damp/moist condition unless it is below freezing.

### **425 Additional Division Requirements**

Refer to the same section of the approved M&RP.

**ATTACHMENT 4-1**  
**CULTURAL RESOURCE SURVEY AND INVENTORY**  
**APPROVED HOLES GVH-1 through GVH-9.**  
**(Relocated to Confidential Binder)**

**ATTACHMENT 4-2**  
**SURFACE LAND OWNER NOTIFICATION**

The surface owner land use agreement is also on file at the Carbon County Recorder's  
office in Price, Utah



**ATTACHMENT 4-3**  
**CULTURAL RESOURCE SURVEY AND INVENTORY**  
**PROPOSED HOLES GVH-10 through GVH-17**  
**(Relocated to Confidential Binder)**

**A CULTURAL RESOURCE SURVEY OF GOB VENT HOLE NO. 10 AND  
ASSOCIATED ACCESS ROAD FOR ANDALEX RESOURCES,  
CARBON COUNTY, UTAH**

by

Michael R. Polk  
Principal Archaeologist

Prepared for:

Andalex Resources, Inc.  
Tower Division  
P.O. Box 902  
Price, Utah 84501

Prepared by:

Sagebrush Consultants, L.L.C.  
3670 Quincy Avenue, Suite 203  
Ogden, Utah 84403

Under Authority of Utah State Antiquities Permit No. U-06-SJ-0734p

Cultural Resources Report No. 1552

May 31, 2006

## INTRODUCTION

On May 25, 2006, Andalex Resources, Inc., Tower Division (Andalex), of Price, Utah, requested that Sagebrush Consultants, L.L.C. (Sagebrush) conduct a cultural resource inventory of the proposed Gob Vent Hole No. 10 (GVH-10) and associated access road corridor on their mining property in Carbon County, Utah. The purpose of this inventory is to identify cultural resource sites which may be present within the proposed project area.

The proposed vent hole location and access road is located in T. 12S., R. 11E., S. 29, 30, 31 and 32, on the USGS 7.5' Quadrangle Deadman Canyon, Utah (1972; P.I. 1978)(Figure 1). The vent hole and access road lie on privately owned lands. The Utah Division of Oil, Gas and Mining (UDOGM), which oversees the mining operation, requires the cultural resource inventory of the property. The project was carried out by the author on May 27, 2006 under the authority of Utah State Antiquities Permit No. U-06-SJ-0734p.

Prior to conducting fieldwork, a GIS file search for previously recorded cultural resource sites and projects located near the current project was completed by Arie Leeftang, of the Antiquities Section, Division of State History, Utah Historic Preservation Office (SHPO), in Salt Lake City, on May 25, 2006. Marty Thomas conducted a file search at the SHPO on May 25, 2006. General Land Office (GLO) plat maps were also examined for cultural resources.

Six cultural resource projects have been carried out in and near the current project area. No cultural resource sites were located within one mile of the current project area on any of these surveys. In 1977, Brigham Young University surveyed drill holes west of the current project area. In 1980, the Antiquities Section, Utah Division of State History, surveyed areas south of the current project area. In 1984, Nickens and Associates surveyed three 160 acre blocks in Sections 29, 32 and 33. In 1986, SENCO-PHENIX surveyed a number of drill hole locations and access corridors south of the project area. In 2005 SENCO-PHENIX surveyed a drill hole pad and access corridor in the immediate area of the project area and then, in a separate project in 2005, surveyed four additional drill hole pads and access corridors near the current project area.

No additional cultural resource sites have been recorded in the vicinity of the current project area. The NRHP was also consulted prior to the commencement of fieldwork for the present project. No NRHP sites were located in the vicinity of the current project area.

## ENVIRONMENT

The project area lies on a high ridge line, in steep terrain, in the southern portion of the Book Cliffs in central Utah. Locally, the project area slopes moderately to the north.

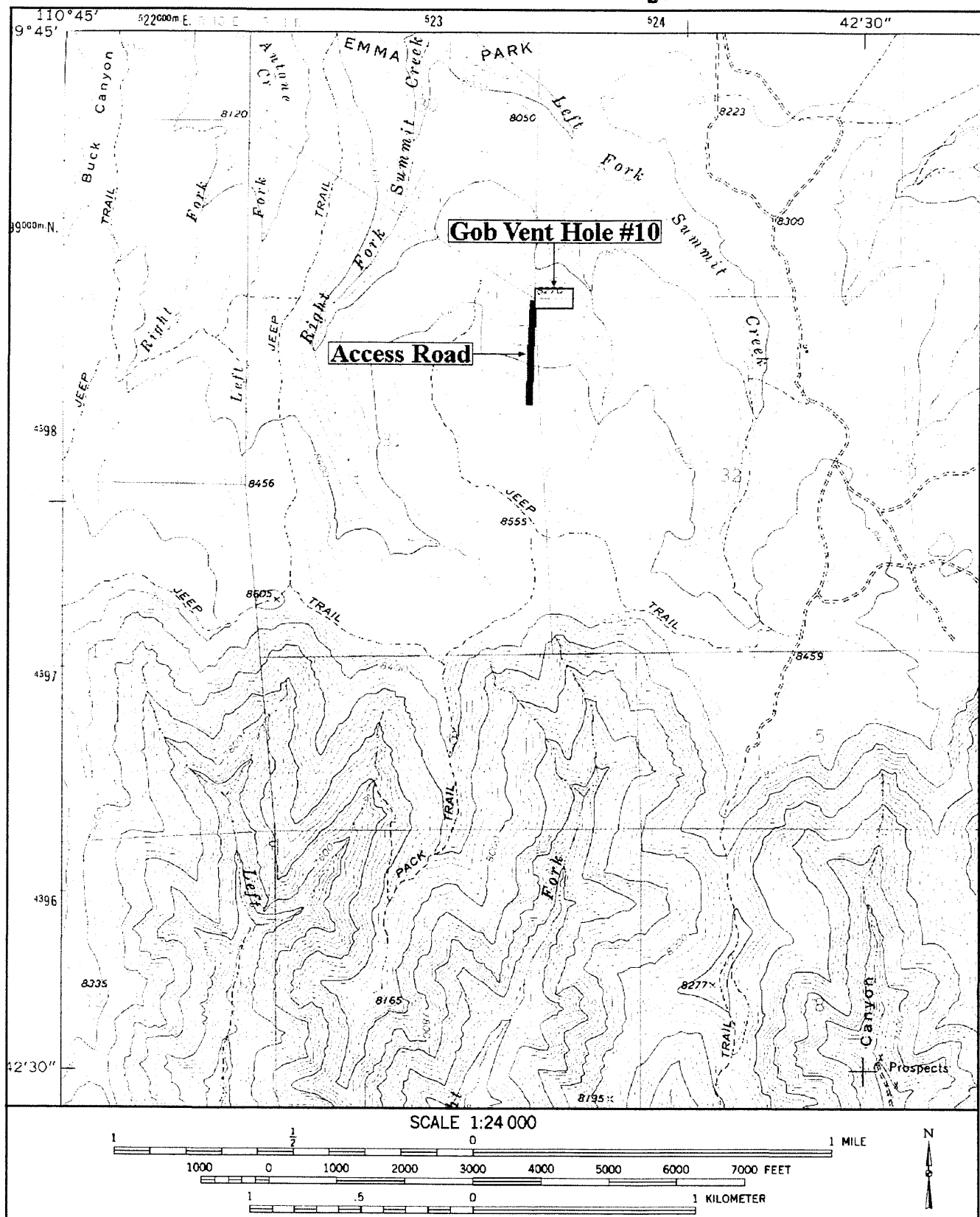


Figure 1. Location of Gob Vent Hole #10 and associated access road. Taken from USGS 7.5' Quadrangle Deadman Canyon, Utah (1972; P.I. 1978).

Soils in this area are poorly developed brown silty loams. Natural erosional features include sheetwash and some arroyo cutting. The elevation of the area surveyed ranges between 8270 and 8540 feet a.s.l.

Vegetation is a mixture of Aspen and Sagebrush-grass community species. The southern and central portion of the access corridor lies entirely within sagebrush-grass community and includes about 30 percent cover of big sagebrush, bunchgrass, and rabbitbrush. The northern portion of the access corridor and the entire vent hole pad lie within an Aspen forest. Species there include aspen trees, wild rose, dandelions, grasses, wild flowers, strawberries and sticky geranium. Ground visibility in this northern area was relatively poor, ranging from 60 to 70 percent vegetation cover. The nearest permanent water source in the area is a permanent spring located within a few meters of the center stake.

Cultural disturbance in the area includes livestock grazing, a two-track road, fence line and a nearby vent hole compressor operation. Also present within the pad area is a piped spring. Water from this spring is piped a few feet north to spill into a large open top stock tank.

## **METHODOLOGY**

This project consisted of a cultural resource inventory for the proposed Gob Vent Hole No. 10 and associated access corridor. The project area consists of one 1.25 ha (3.08 ac) parcel of land, measuring (480-by-280 ft), centered on the proposed vent hole and an associated access road measuring 579 m (1900 ft) long by 30 m (100 ft) wide. The vent hole location and access corridor was inventoried in parallel transects spaced no more than 15 m (50 ft) apart. The total area surveyed during this cultural resource inventory totals 3.01 ha (7.44 ac).

## **RESULTS**

A cultural resource inventory was carried out for the proposed Gob Vent Hole No. 10 and associated access road. No cultural resource sites or isolated finds were identified during the inventory.

## **RECOMMENDATIONS**

A cultural resource inventory was carried out for the proposed Gob Vent Hole No. 10 and associated access road. No cultural resource sites or isolated finds were identified during the inventory. As such, cultural resource clearance is recommended for the proposed project.

This investigation was conducted with techniques which are considered to be adequate for evaluating cultural resources that could be adversely affected by the proposed project. However, should such resources be discovered during construction, a report should be made immediately to the Utah Division of Oil, Gas and Mining as well as to the State Historic Preservation Office, Salt Lake City.





**SENCO-PHENIX**

**An Intensive Cultural Resource Survey and Inventory of Seven  
Gob Vent Hole Well Pads and Access Corridors**

**Carbon County, Utah  
(Private Land)**

**PERFORMED FOR  
UTAHAMERICAN Energy, Inc.  
Tower Mine**

**In Accordance with  
Utah State Guidelines  
Antiquities Permit #U06SC1322p**

**SPUT-539  
September 29, 2006**

**John A. Senulis**

**Direct Charge of Fieldwork**

# UTAH SHPO COVER SHEET

Project Name: An Intensive Cultural Resource Survey and Inventory of Seven  
Gob Vent Hole Well Pads and Access Corridors

UTAHAMERICAN Energy, Inc.  
Tower Mine

State # U06SC1322p

Report Date: September 29, 2006

County (ies): Carbon,

Principal Investigator/ Field Supervisor: John A. Senulis/John Senulis

Records Search/Location/Dates: September 26, 2006, Price River Field Office of the BLM

Acreage Surveyed: 39 acres

Intensive Acres: 39

Recon/Intuitive Acres: 0

U.S.G.S. 7.5 Quads: Helper, UT (1972) and Deadman Canyon, UT (1972)

Sites Reported	Number	Smithsonian Site #(s):
Archeological Sites:	0	
Revisit (No IMACS update)	0	
Revisit (IMACS update attch.)	0	
New Sites (IMACS attached)	0	
Archeological Site Total:	0	
Historic Structures:	0	
(USHS Site Form Attached)		
Total NRHP Eligible Sites,	0	

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## Checklist of Required Items:

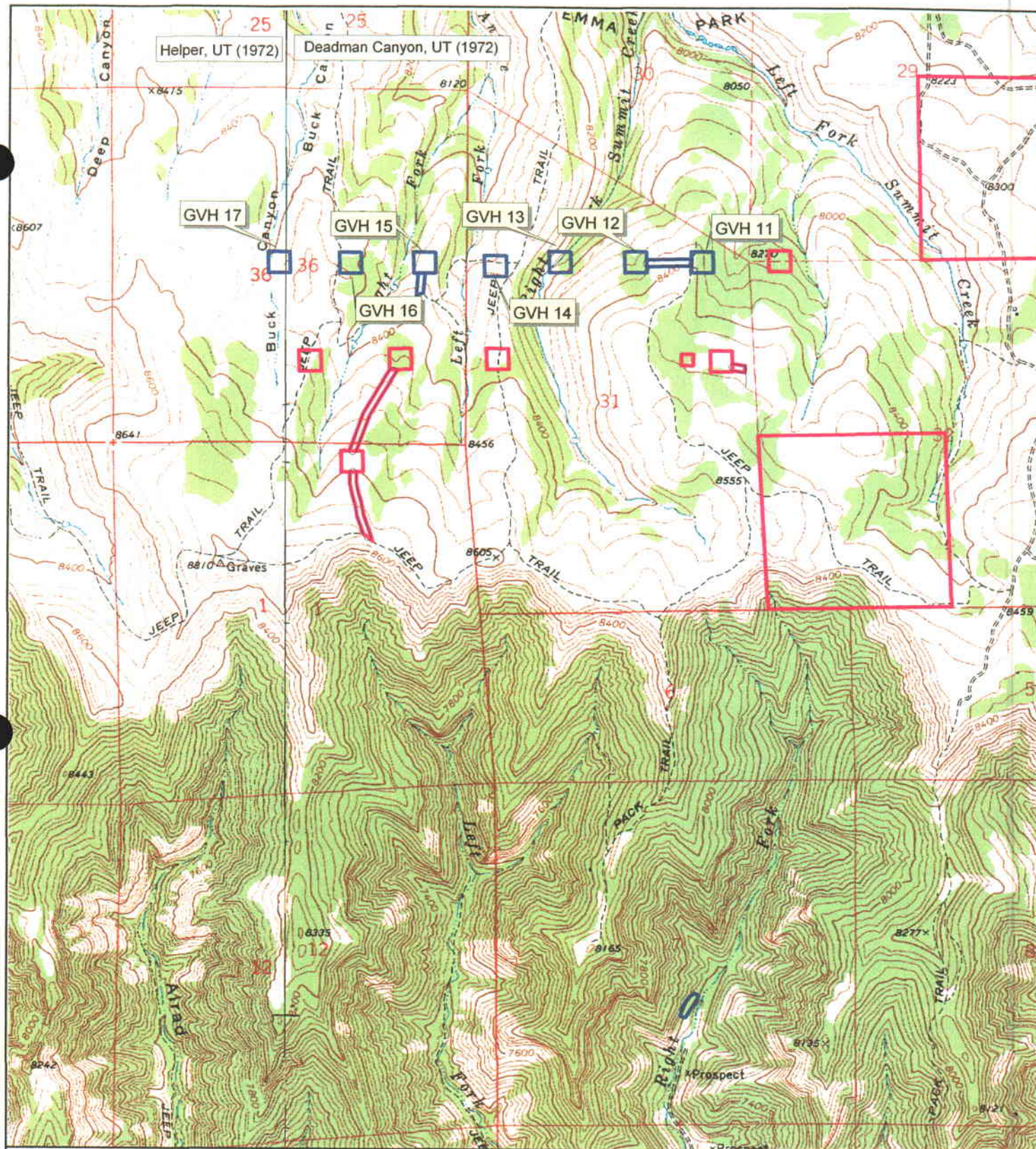
1. X 1 Copy of Final Report
2. X Copy of U.S.G.S. 7.5' map showing surveyed/excavated area
3. Completed IMACS Site Inventory Forms Including
  - \_\_\_\_\_ Parts A and B or C
  - \_\_\_\_\_ IMACS Encoding Form
  - \_\_\_\_\_ Site Sketch Map
  - \_\_\_\_\_ Photographs
  - \_\_\_\_\_ Copy of USGS 7.5' Quad with Smithsonian site Number
4. X Completed Cover Sheet

## Abstract

SENCO-PHENIX performed an intensive cultural resource survey on the Gob Vent Hole (GVH) 11, 12, 13, 14, 15, 16, 17 well pads, five-acre buffers and access corridors. The proposed well locations are located on Private land. The purpose of the survey was to identify and evaluate cultural resources that may exist within the project area.

No cultural resources were located and the potential for undetected remains is remote. A finding of **No Effect** is appropriate and **Archeological Clearance** is recommended.





SENCO-PHENIX



Scale 1:24,000  
1" = 2,000'

- Proposed Drill Holes
- Previous Survey
- Eligible Sites
- Ineligible Sites

Gob Vent Holes  
Tower Mine,  
UTAHAMERICAN Energy, Inc.  
Carbon County, Utah  
Section 36, T12S, R10E  
Section 31, T12S, R11E  
September 2006  
SPUT-538



### **Project Location**

The survey area is in Section 36, Township 12 South, Range 10 East, and Section 31, T12S, R11E, Carbon County, Utah. The project area is shown on the enclosed copy of U.S.G.S. composite 7.5' Quad: Helper, Utah (1972) and Deadman Canyon, Utah (1972). The well pads were staked.

### **Specific Environment**

The survey area is on a bench overlooking the Price Basin to the south and Emma Park to the north. Soils are tan alluvium, gravelly clay loams. Vegetation is dense low to medium sagebrush with assorted grasses, forbs and shrubs. There are stands of aspen scattered through the project area. There is no permanent water in the project area.

### **Previous Research**

A file search of the SENCO-PHENIX reports and at the BLM Price Field Office on September 27, 2005, indicated that the following projects had been performed:

The file search revealed the following:

- 1977, BYU surveyed drill holes west of the proposed project. No cultural resources were located.
- 1980, Antiquities Section, Utah Division of State History, surveyed the Canyon bottoms south of the current lease expansion. They recorded the Zion, Blue Flame/Sutton and Rio Grande mines. None of the mines were considered eligible for the NRHP.
- 1984, Nickens and Associates surveyed three 160-acre blocks in Sections 29, 32 and 33, northeast of the project area. No cultural resources were located.
- 1986, SENCO-PHENIX surveyed several drill hole locations and access corridors just south of the proposed project. No cultural resources were located.
- 2005, SENCO-PHENIX surveyed a drill hole pad and access corridor in the current project area. No cultural resources were located.
- 2005, SENCO-PHENIX surveyed 4 well pads and access corridor in the current project area. No cultural resources were located.
- 2006, Sagebrush Archeological Consultants surveyed the GVH 10 well pad. No cultural resources were located.

### **Methodology**

John and Jeanne Senulis of SENCO-PHENIX performed a Class III intensive walkover survey of the proposed seven 100 by 100 foot well pads and five-acre buffers on September 28, 2006. Meandering parallel transects no further spaced than 15 meters were employed. Most of the drill holes were adjacent to existing roads. The access corridors were surveyed to a 100-foot width. Locations were checked by using a gps unit. Special attention was given to areas of subsurface soil exposure from animal burrowing, and erosion. All field notes and digital photographs are on file at the offices of SENCO-PHENIX in Price, Utah.

### **Findings and Recommendations**

No cultural resources were located and the potential for undetected remains is remote. A finding of no effect is appropriate and archeological clearance is recommended.

These recommendations are subject to approval by the Utah SHPO.

## References

Berge, Dale L.

- 1977 Drill Hole Clearance Letter to BLM, Brigham Young University, Provo, Utah.  
(77-04)

Lindsay, La Mar, Bruce Hawkins and Gregory Seward

- 1980 *An Archeological Survey of Portions of Fiasco Canyon, Starpoint Canyon and Straight Canyon Near Price, Utah*, Antiquities Section, Utah Division of State History, Salt Lake City, Utah.

Polk, Michael

- 2006 *A Cultural Resource Survey of Andalex Resources Gob Vent Hole # 10*, Sagebrush Archeological Consultants, Ogden, Utah

Reed, Alan D. and Susan Chandler

- 1984 *A Sample Oriented Cultural Resource Inventory in Carbon, Emery and Sanpete Counties*, BLM through Nickens and Associates, Montrose Colorado.  
(84-30)

Senulis, John A.

- 1985 *Intensive Cultural Resource Survey and Inventory of the Left Fork of Deadman Canyon Coal Mine*, SENCO-PHENIX, Salt Lake City, Utah. (86-424)
- 2005 *An Intensive Cultural Resource Survey and Inventory of the Gob Vent Hole #4 Well Pad and Access Corridor*, SENCO-PHENIX, Price, Utah. (05-593)
- 2005 *An Intensive Cultural Resource Survey and Inventory of 4 Gob Vent Holes Well Pads and Access Corridors*, SENCO-PHENIX, Price, Utah. (05-682)





**SENCO-PHENIX**

**An Intensive Cultural Resource Survey and Inventory of Seven  
"A" Series Gob Vent Hole Well Pads**

**Carbon County, Utah  
(Private Land)**

**PERFORMED FOR  
UTAHAMERICAN Energy, Inc.  
Tower Mine**

**In Accordance with  
Utah State Guidelines  
Antiquities Permit #U06SC1604p**

**SPUT-545  
December 6, 2006**

**John A. Senulis**

**Direct Charge of Fieldwork**

# UTAH SHPO

## COVER SHEET

Project Name: **An Intensive Cultural Resource Survey and Inventory of Seven "A" Series Gob Vent Hole Well Pads**

UTAHAMERICAN Energy, Inc.  
Tower Mine

State #U06SC1604p

Report Date: December 6, 2006

County (ies): Carbon,

Principal Investigator/ Field Supervisor: John A. Senulis/John Senulis

Records Search/Location/Dates: September 20, 2006, Price River Field Office of the BLM

Acreage Surveyed: 35 acres

Intensive Acres: 30

Recon/Intuitive Acres: 5

U.S.G.S. 7.5 Quads: Deadman Canyon, UT (1972) & Helper, Utah (1972)

Sites Reported	Number	Smithsonian Site #(s):
Archeological Sites:	0	
Revisit (No IMACS update)	0	
Revisit (IMACS update attch.)	0	
New Sites (IMACS attached)	0	
Archeological Site Total:	0	
Historic Structures:		
(USHS Site Form Attached)		
Total NRHP Eligible Sites,		

---

### Checklist of Required Items:

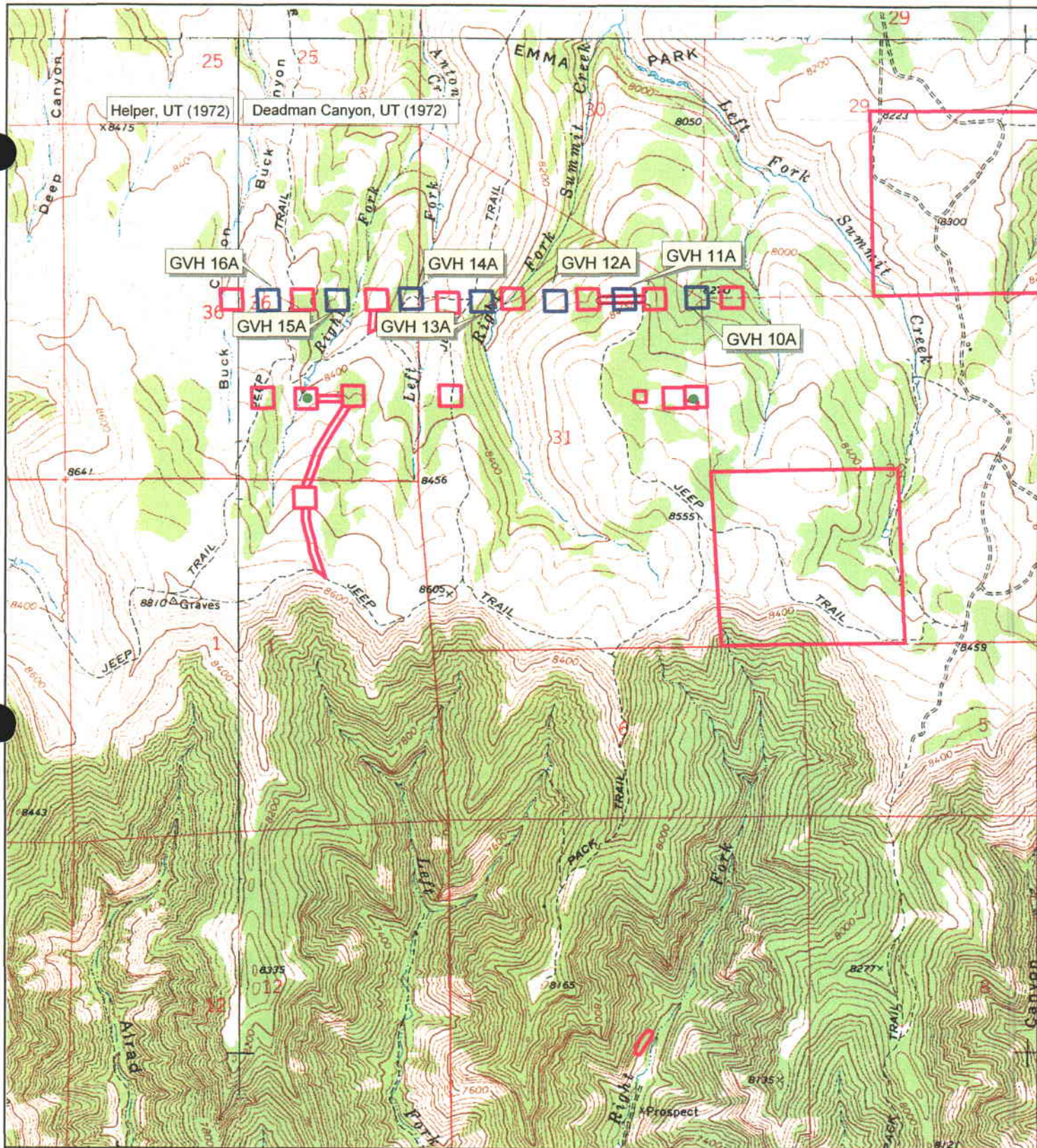
1. X 1 Copy of Final Report
2. X Copy of U.S.G.S. 7.5' map showing surveyed/excavated area
3. Completed IMACS Site Inventory Forms Including
  - \_\_\_\_\_ Parts A and B or C
  - \_\_\_\_\_ IMACS Encoding Form
  - \_\_\_\_\_ Site Sketch Map
  - \_\_\_\_\_ Photographs
  - \_\_\_\_\_ Copy of USGS 7.5' Quad with Smithsonian site Number
4. X Completed Cover Sheet

## **Abstract**

SENCO-PHENIX performed an intensive cultural resource survey on the Gob Vent Hole (GVH) 10A, 11A, 12A, 13A, 14A, 15A, 16A well pads and five-acre buffers. The proposed well locations are located on Private land. The purpose of the survey was to identify and evaluate cultural resources that may exist within the project area.

No cultural resources were located and the potential for undetected remains is remote. A finding of No Effect is appropriate and Archeological Clearance is recommended.

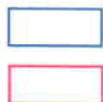




SENCO-PHENIX



Scale 1:24,000  
1" = 2,000'



Current Survey

Previous Survey



Eligible Sites



Ineligible Sites

"A" Series Drill Holes  
UtahAmerican Energy, Tower Mine  
Carbon County, Utah  
Section 36, T12S, R10E  
Section 31, T12S, R11E  
December 2006  
SPUT-543



### **Project Location**

The survey area is in Section 36, Township 12 South, Range 10 East, and Section 31, T12S, R11E, Carbon County, Utah. The project area is shown on the enclosed copy of U.S.G.S. composite 7.5' Quad: Helper, Utah (1972) and Deadman Canyon, Utah (1972). The well pads were not staked but they were located using UTMS and gps units.

### **Specific Environment**

The survey area is on a bench overlooking the Price Basin to the south and Emma Park to the north. Soils are tan alluvium, gravelly clay loams. Vegetation is dense low to medium sagebrush with assorted grasses, forbs and shrubs. There are stands of aspen scattered through the project area. There is no permanent water in the project area.

### **Previous Research**

A file search of the SENCO-PHENIX reports and at the BLM Price Field Office on September 20, 2007, indicated that the following projects had been performed:

The file search revealed the following:

- 1977, BYU surveyed drill holes west of the proposed project. No cultural resources were located.
- 1980, Antiquities Section, Utah Division of State History, surveyed the Canyon bottoms south of the current lease expansion. They recorded the Zion, Blue Flame/Sutton and Rio Grande mines. None of the mines were considered eligible for the NRHP.
- 1984, Nickens and Associates surveyed three 160-acre blocks in Sections 29, 32 and 33, northeast of the project area. No cultural resources were located.
- 1986, SENCO-PHENIX surveyed several drill hole locations and access corridors just south of the proposed project. No cultural resources were located.
- 2005, SENCO-PHENIX surveyed a drill hole pad and access corridor in the current project area. No cultural resources were located.
- 2005, SENCO-PHENIX surveyed 4 well pads and access corridor in the current project area. No cultural resources were located.
- 2006, Sagebrush Archeological Consultants surveyed the GVH 10 well pad. No cultural resources were located.
- 2006, SENCO-PHENIX surveyed seven GVH pads and access corridors. No cultural resources were located.

### **Methodology**

John and Jeanne Senulis of SENCO-PHENIX performed a Class III intensive walkover survey of the proposed seven 100 by 100 foot well pads and five-acre buffers on September 28, 2006. Meandering parallel transects no further spaced than 15 meters were employed. Most of the drill holes were adjacent to existing roads. The access corridors were surveyed to a 100-foot width. Locations were checked by using a gps unit. Special attention was given to areas of subsurface soil exposure from animal burrowing, and erosion. All field notes and digital photographs are on file at the offices of SENCO-PHENIX in Price, Utah.

### **Findings and Recommendations**

No cultural resources were located and the potential for undetected remains is remote. A finding of no effect is appropriate and archeological clearance is recommended.

These recommendations are subject to approval by the Utah SHPO.

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(77-04)

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- 1984 *A Sample Oriented Cultural Resource Inventory in Carbon, Emery and Sanpete Counties*, BLM through Nickens and Associates, Montrose Colorado.  
(84-30)

Senulis, John A.

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- 2005 *An Intensive Cultural Resource Survey and Inventory of the Gob Vent Hole #4 Well Pad and Access Corridor*, SENCO-PHENIX, Price, Utah. (05-593)
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- 2006 *An Intensive Cultural Resource Survey and Inventory of Seven Gob Vent Hole Well Pads and Access Corridors*, SENCO-PHENIX, Price, Utah.(06-1322)



(Revised)  
FEBRUARY 2007

**CHAPTER 5**  
**ENGINEERING**

## TABLE OF CONTENTS

<u>Section</u>	<u>Page</u>
<b>510 INTRODUCTION</b>	<b>5-1</b>
<b>511 General Requirements</b>	<b>5-1</b>
<b>512 Certification</b>	<b>5-1</b>
512.100 Cross Sections and Maps	5-1
512.200 Plans and Engineering Designs	5-2
<b>513 Compliance with MSHA Regulations and MSHA Approval</b>	<b>5-2</b>
513.100 Coal Processing Waste Dams and Embankments	5-2
513.200 Impoundments and Sedimentation Ponds	5-2
513.300 Underground Development Waste, coal Processing Waste, and Excess Spoil	5-2
513.400 Refuse Piles	5-2
513.500 Underground Openings to the Surface	5-2
513.600 Discharge to Underground Mine	5-3
513.700 Surface Coal Mining and Reclamation Activities	5-3
513.800 Coal Mine Waste Fire	5-3
<b>514 Inspection</b>	<b>5-3</b>
514.100 Excess Spoil	5-3
514.200 Refuse Piles	5-3
514.300 Impoundments	5-3
<b>515 Reporting and Emergency Procedures</b>	<b>5-3</b>
515.100 Slides	5-3
515.200 Impoundments Hazards	5-3
515.300 Temporary Cessation of Operations	5-3
<b>520 OPERATION PLAN</b>	<b>5-4</b>
<b>521 General</b>	<b>5-4</b>
521.100 Cross Sections and Maps	5-4
521.200 Signs and Markers	5-4

## TABLE OF CONTENTS (Continued)

<u>Section</u>	<u>Page</u>
522 Coal Recovery .....	5-5
523 Mining Methods .....	5-5
524 Blasting and Explosives .....	5-5
525 Subsidence .....	5-5
526 Mine Facilities .....	5-5
526.100 Mine Structures and Facilities .....	5-5
526.200 Utility installation and Support Facilities .....	5-5
527 Transportation Facilities .....	5-6
527.100 Road Classification .....	5-6
527.200 Description of Transportation Facilities .....	5-6
528 Handling and Disposal of Coal, Excess Spoil, and Coal Mine Waste .....	5-10
529 Management of Mine Openings .....	5-10
530 OPERATIONAL DESIGN CRITERIA AND PLANS .....	5-10
531 General .....	5-10
532 Sediment Control .....	5-10
533 Impoundments .....	5-10
534 Roads .....	5-10
535 Spoil .....	5-11
536 Coal Mine Waste .....	5-11
537 Regraded Slopes .....	5-11
537.100 Division Approval .....	5-11

## TABLE OF CONTENTS (Continued)

<u>Section</u>	<u>Page</u>
537.200 Regrading of Settled and Revegetative Fills .....	5-11
<b>540 RECLAMATION PLAN .....</b>	<b>5-11</b>
<b>541 General .....</b>	<b>5-11</b>
541.100 Commitment .....	5-11
541.200 Surface Coal Mining and Reclamation .....	5-11
541.300 Underground Coal Mining and Reclamation Activities .....	5-11
541.400 Environmental Protection Performance Standards .....	5-11
<b>542 Narratives, Maps, and Plans .....</b>	<b>5-12</b>
542.100 Reclamation Timetable .....	5-12
542.200 Plan for Backfilling, Soil Stabilization, Compacting, and Grading .....	5-12
542.300 Final Surface Configuration Maps and Cross Sections .....	5-12
542.400 Removal of Temporary Structures .....	5-12
542.500 Removal of Sedimentation Pond .....	5-12
542.600 Roads .....	5-12
542.700 Final Abandonment of Mine Openings and Disposal Areas ..	5-12
542.800 Estimated Cost of Reclamation .....	5-13
<b>550 RECLAMATION DESIGN CRITERIA AND PLANS .....</b>	<b>5-13</b>
<b>551 Casting and Sealing of Underground Openings .....</b>	<b>5-13</b>
<b>552 Permanent Features .....</b>	<b>5-13</b>
552.100 Small Depressions .....	5-13
552.200 Permanent Impoundments .....	5-13
<b>553 Backfilling and Grading .....</b>	<b>5-13</b>
553.100 Disturbed Area Backfilling and Grading .....	5-13
553.200 Spoil and Waste .....	5-14
553.250 Refuse Piles .....	5-14
553.300 Exposed Coal Seams, Acid and Toxic Forming Materials and Combustible .....	5-14
553.400 Cut and Fill Terraces .....	5-14

## TABLE OF CONTENTS (Continued)

<u>Section</u>	<u>Page</u>
553.500 Highwall From Previously Mined Areas .....	5-14
553.600 Previously Mined Areas .....	5-14
553.700 Backfilling and Grading - Thin Overburden .....	5-14
553.800 Backfilling and Grading - Thick Overburden .....	5-14
553.900 Regrading of Settled and Revegetated Fills .....	5-14
<b>560 PERFORMANCE STANDARDS .....</b>	<b>5-15</b>

## LIST OF FIGURES

<b>Figure 5-1</b>	Typical Gob Gas Vent Hole Drilling Plan
<b>Figure 5-2</b>	Typical Gob Gas Vent Hole Operation Plan
<b>Figure 5-3</b>	Typical Gob Gas Vent Hole Pad Cross Section
<b>Figure 5-4</b>	Typical Gob Gas Vent Hole
<b>Figure 5-5</b>	Typical Road Cross Sections
<b>Figure 5-6</b>	Projected Gob Gas Vent Hole Reclamation Schedule
<b>Figure 5-7</b>	GVH #1 - As-Constructed
<b>Figure 5-8</b>	GVH #3 - As-Constructed
<b>Figure 5-9</b>	GVH #4 - As-Constructed
<b>Figure 5-10</b>	GVH #5 - As-Constructed
<b>Figure 5-11</b>	GVH #6 - As-Constructed
<b>Figure 5-12</b>	GVH #5A - As-Constructed
<b>Figure 5-13</b>	GVH #7/#7A - As-Constructed
<b>Figure 5-14</b>	GVH #8 - As-Constructed
<b>Figure 5-15</b>	GVH #9 - As-Constructed
<b>Figure 5-16</b>	GVH #8A - As-Constructed

## **510 INTRODUCTION**

This chapter provides a discussion of general engineering aspects, an operation plan, a reclamation plan, design criteria, and performance standards related to the degassification well sites. The activities associated with the construction and reclamation of the well sites have been or will be designed, located, constructed, maintained, and reclaimed in accordance with the operation and reclamation plans.

Designs and other information herein presented may be of a general nature or in the form of typicals for proposed sites not yet accessible for detailed surveying or studies. Site specific information will be provided in this chapter as it becomes available.

### **511 General Requirements**

The permit application includes descriptions of construction, maintenance, and reclamation operations of the completed and proposed well sites with maps and plans. Potential environmental impact as well as methods and calculations utilized to achieve compliance with the design criteria are also presented.

Completed holes are GVH#1, GVH#3, GVH#4, GVH#5, GVH#5A, GVH#6, GVH#7, GVH#7A, GVH#8, GVH#8A, and GVH#9. The following is a list of holes proposed for approval - GVH#10, GVH#10A, GVH#11, GVH#11A, GVH#12, GVH#12A, GVH#13, GVH#13A, GVH#14, GVH#14A, GVH#15, GVH#15A, GVH#16, GVH#16A and GVH#17. All holes are shown on Figure 1-1.

Due to required changes in the mining plan, hole GVH#5B will not be drilled and has been shown as eliminated, although the site has been approved and included in the bonding.

### **512 Certification**

Where required by the regulations, cross sections and maps in this permit application have been prepared by or under the direction of, and certified by, qualified registered professional engineers or land surveyors. As appropriate, these persons were assisted by experts in the fields of hydrology, geology, biology, etc.

#### **512.100 Cross Sections and Maps**

Cross sections for the degassification well pads are provided upon completion of surveys. Typical road cross sections are shown on Figure 5-5.



## **512.200 Plans and Engineering Designs**

**Excess Spoil** - No excess spoil will be generated from the well sites.

**Durable Rock Fills** - No durable rock fills will exist at the well sites.

**Coal Mine Waste** - No coal mine waste will exist at the well sites.

**Impoundments** - Refer to Section 733.200 of this submittal.

**Ancillary Roads** - Short sections of road may be required to access certain well sites. Topsoil will be stripped from the road alignment and stored with the topsoil stripped from the pad area prior to grading the new access road. When possible, well sites will be placed on existing roads.

Existing and proposed access routes to all well sites are shown on Figure 1-1 of this Appendix.

**Variance from Approximate Original Contour** - No variance from approximate original contour is required for the well sites.

## **513 Compliance with MSHA Regulations and MSHA Approval**

### **513.100 Coal Processing Waste Dams and Embankments**

No coal processing waste dams and embankments will exist at the well sites.

### **513.200 Impoundments and Sedimentation Ponds**

Refer to Section 733.200 of this submittal.

### **513.300 Underground Development Waste, Coal Processing Waste, and Excess Spoil**

No underground waste, coal processing waste, and excess spoil will exist at the well sites.

### **513.400 Refuse Piles**

No refuse piles will exist at the well sites.

### **513.500 Underground Openings to the Surface**

The well will be equipped with a valve that will be closed and locked when not in use. A typical well head is shown in Figure 5-4.

### **513.600 Discharge to Underground Mine**

No discharge to the underground mine will occur at the well sites.

### **513.700 Surface Coal Mining and Reclamation Activities**

No surface coal mining, or reclamation activities associated with surface coal mining will occur at the well sites.

### **513.800 Coal Mine Waste Fire**

No coal waste will be developed, therefore, no coal waste fires will occur at the well sites.

## **514 Inspection**

### **514.100 Excess Spoil**

No excess spoil will be stored at the well sites.

### **514.200 Refuse Piles**

No refuse piles will exist at the well sites.

### **514.300 Impoundments**

Refer to Section 7133.200 of this submittal.

## **515 Reporting and Emergency Procedures**

### **515.100 Slides**

Refer to Section 515.100 in the approved M&RP.

### **515.200 Impoundment Hazards**

No impoundments will exist at the well sites.

### **515.300 Temporary Cessation of Operations**

If temporary cessation of the mining operations does occur, the wells will remain open. Once liberation of the gob gas is completed, the wells will be sealed as discussed in Section 542.700 of this submittal.

## **520 OPERATION PLAN**

### **521 General**

Detailed maps are provided of each of the well sites when conditions allow access.

#### **521.100 Cross Sections and Maps**

**Existing Surface and Subsurface Facilities Features** - No buildings are located on or within 1,000 feet of any of the well sites.

**Landowner, Right-of-Entry, and Public Interest** - The land which the wells will be drilled on is owned by Dave R. & Mildred Cave, et al., and Mathis Land, Inc. Andalex Resources, Inc. has completed landowner agreements to allow access for the construction and drilling of the wells (see Attachment 4-2).

**Mining Sequence and Planned Subsidence** - Refer to Section 525.

**Land Surface Configuration** - Surface contours of undisturbed well sites will be included when completed.

**Surface Facilities** - No permanent surface facilities will exist at the well sites.

#### **521.200 Signs and Markers**

**Mine and Permit Identification Signs** - A mine and permit identification sign will be displayed at each well site. This sign will be a design that can be easily seen and read, will be made of durable material, will conform to local regulation, and will be maintained until after the release of all bonds for the well site areas. The sign will contain the following information:

- Mine name,
- Company name,
- Company address and telephone number,
- MSHA identification number, and
- Permanent program permit identification number

**Perimeter Markers** - The perimeter of all areas affected will be clearly marked before beginning drilling activities. The markers will be a design that can be easily seen and read, will be made of durable material, will conform to local regulations, and will be maintained until after the release of all bonds for the permit area.

**Buffer Zone Markers** - Stream buffer zone markers will not be required at any of the well sites.

**Topsoil Markers** - Markers will be placed on all topsoil stockpiles. These markers will be a design that can be easily seen and read, will be made of durable material, will conform to local regulations, and will be maintained until topsoil is redistributed on the well sites.

**Construction Markers** - Not applicable.

## **522 Coal Recovery**

No coal recovery will be performed at the well sites.

## **523 Mining Methods**

No mining will be performed at the well sites.

## **524 Blasting and Explosives**

No explosives are to be used at the well sites.

## **525 Subsidence**

No subsidence will occur at the well sites, as a result of drilling and development of the degassification well sites. Subsidence could occur at the well site because of underground mining see Section 525 of the approved M&RP.

## **526 Mine Facilities**

### **526.100 Mine Structures and Facilities**

No buildings exist or are proposed at the well sites; therefore, no existing building will be used in connection with or to facilitate this proposed coal mining and reclamation plan.

### **526.200 Utility and Support Facilities**

No utilities are to be installed at the well sites. A portable exhaust unit will be temporarily installed to draw gob gas to the surface from the mined panel. The exhaust blower will be started by using propane from portable tanks. Once started and running, the unit will be powered by burning the extracted gas. Excess gob gas will be vented to the atmosphere. The blower is approximately 12-feet long by 6-feet wide and about 10-feet tall. It is not known how long the degassification of the longwall panel will take.

## **527 Transportation Facilities**

### **527.100 Road Classification**

Well sites will be developed near existing private roads whenever possible. The new access roads will be classified as ancillary roads and will be maintained by the permittee.

### **527.200 Description of Transportation Facilities**

The well sites have been chosen close to existing roads whenever possible in the area to limit surface disturbance. The existing roads were constructed and are maintained by the land owner. The existing roads are approximately 16 feet wide. See Figure 5-5 for a typical cross section of the existing roads.

The following is a description of each of the roads used to access the GVH Sites:

Right Fork of Deadman Canyon - This road is located in the bottom of Deadman Canyon north of the Centennial Project Minesite surface facilities. The road was existing, constructed by the surface owner; however, it did require minor drainage control upgrades in the form of 18" and 24" culverts, and slight widening of sharp turns for drilling equipment access. This road is approximately 12,300' long with an average slope of 11.79% and is approximately 16' wide. The road runs from the Centennial Minesite to the top of the ridge. The road is native rock and gravel surfaced, and is protected from runoff by a combination of berms, road ditches and culverts. This road will remain in place upon completion of the drilling project.

GVH-5 - This road runs from the top of Deadman Canyon to the GVH-5 Site. This is an existing road, approximately 16' wide, 4400' in length, with an average slope of approximately 5.00%. The road is constructed on native material and protected from runoff by berms, ditches and culverts as needed.. There are no plans to remove or reclaim this road.

GVH-5A - This road was constructed from GVH-5 west approximately 800' to GVH-5A. The road is approximately 16' wide with a slight slope to the pad.

GVH-5B - This site is located approximately ½ way between GVH-5 and GVH-5A and is on the existing road to GVH-5A. The newly constructed OSO Energy pipeline and associated disturbance also runs through this site.

GVH-1 - This is a short section of road running from Road GVH-5 to the GVH-1 Site. The road was constructed on native material by ARI, and is approximately 16' wide, 300' in length and has an average slope of 3.33%. The drainage is controlled by ditches and berms, with runoff retained on the pad. This road will be removed and reclaimed unless requested otherwise by the landowner.

GVH-6 - This is a constructed access road running from Road GVH-5 to the GVH-6 Site. The road is approximately 16' wide, 4300' long and has an average slope of 2.67%. It is constructed on native material, with gravel used as needed on soft areas. Drainage is controlled by a combination of ditches and berms. This road will be removed and reclaimed unless otherwise directed by the landowner.

Ridge Road - This is an existing road along the ridge above the Right and Left Forks of Deadman Canyon. The road is approximately 16' wide, 7100' long and has an average grade of 3.10%. It runs westward from the top of the Right Fork of Deadman Canyon to the turnoff to the road to GVH-9. The road is constructed on native material and being on the ridgeline, has need for only minimal drainage control in the form of ditches where needed. This road will remain in place after the project is completed.

GVH-3 - This is an existing road from the Ridge Road to the GVH-3 Site. The road is approximately 16' wide, 1200' long and has an average grade of 4.17%. The road is constructed on native material and hydrologic controls consist of berms and ditches. This road is not scheduled for removal after the project is completed.

GVH-7 - This section of road is from GVH-3 to GVH-7 and is a continuation of the existing road to GVH-3. This section is approximately 16' wide, 1600' long and at an average grade of 8.13%. The road is constructed on native material and hydrologic controls are primarily from ditches. This road is also scheduled to remain after the project.

GVH-7A - This site will be a re-drill of existing site GVH-7, and will use the existing access road to GVH-7.

GVH-8 - This road is from GVH-4 to GVH-8. The road is approximately 16' wide, 1700' long and at an average grade of 8.0%. The road is on native material and hydrologic controls are primarily from ditches.

GVH-8A - This site is accessed by a short spur road to be constructed from the road which presently provides access to GVH-8. The spur road is approximately 650' long, 16' wide with an average grade of approximately 7.5%. The road is constructed on native material with runoff control primarily by berms. The spur road will be removed and reclaimed unless otherwise directed by the landowner.

GVH-4 - This road runs from the Ridge Road to the GVH-4 Site. This road was constructed by ARI, and is approximately 16' wide, 1100' long at an average grade of approximately 3.64%. The road was constructed on native material, and runoff is controlled by ditches and berms with containment on the pad. This road will be removed and reclaimed unless otherwise requested by the landowner.



GVH-9 - This is an existing road from the Ridge Road to the GVH-9 Site. The road is approximately 16' wide, 3500' long and has an average grade of approximately 8.14%. The road is constructed on native material and runoff is controlled by ditches and berms. Since this is also an existing road, it will not be removed unless requested by the landowner.

GVH-10 - This is an existing road from the GVH-5 site to the GVH-10 site. The road parallels the fence line and is approximately 16' wide, 1700' long and has an average grade of approximately 12.5%. The road is constructed on native material, and hydrologic controls are primarily from ditches and berms. The road is not scheduled for removal after the project is completed.

GVH-10A - This site will be on a constructed road from GVH-10 to the GVH-10A site. The road will be approximately 800' in length, 16' wide and at an average grade of -3.75%. The road will be constructed on native material with hydrologic controls primarily by ditches and berms. This road is not scheduled to be removed.

GVH-11 - This site will be on the existing road below GVH-6. The road is approximately 16' wide at an average grade of -5.00%. The existing road is on native material with drainage controls primarily by ditches or berms. This road is not scheduled to be removed.

GVH-11A - This road will be constructed from the existing road at site GVH#11. The constructed road will be approximately 450' in length, 16' wide and at an average grade of -8.88%. The road will be built on native material with runoff control by ditches or berms. This road is scheduled to be removed and reclaimed.

GVH-12 - This road will also be constructed from the above referenced road to GVH#11A. It will be approximately 600' in length, 16' wide and at an average grade of -10.00%. It will be built on native material and runoff control will be primarily from ditches or berms. This road will be removed and reclaimed.

GVH-12A - This road will be constructed from the above referenced road to GVH#12. The new road will be approximately 600' long, 16' wide at an average grade of -7.5%. It will be built on native material with runoff control by ditches or berms. This road is also planned to be removed and reclaimed.

GVH-13 - This site is on an existing road on the east side of the Right Fork of Summit Creek, as shown on Figure 1-1. The road is approximately 16' wide and at an average grade of -6.67%. It is built on native material with runoff control by ditches. This road is not scheduled to be removed and reclaimed at the completion of operations.

GVH-13A - This site is on an existing road below GVH-7. The existing road is approximately 16' wide and at an average grade of -8.13%. The road is constructed on native material with hydrologic controls primarily from ditches. This road is scheduled to remain.

GVH-14 - This site is also located on the existing road below GVH-7 as referenced above. It is also approximately 16' wide, on native material with runoff control by ditches. This road will also remain after the project.

GVH-14A - This site is also on the above referenced existing road for GVH-13A and GVH-14. The road is approximately 16' wide and constructed on native material. Runoff control is primarily by ditches. This road will also remain after the project.

GVH-15 - This will be a newly constructed road from the existing road below GVH-8. The new road will be approximately 600' long, 16' wide and have an average grade of -10.83%. It will be constructed on native material with runoff control by ditches and/or berms. This road will be removed and reclaimed.

GVH-15A - This road will be constructed from the existing road below GVH-9. It will be approximately 900' long, 16' wide and have an average grade of -13.33%. It will be constructed on native materials with runoff control by ditches, water bars and/or berms. It is scheduled to be removed and reclaimed.

GVH-16 - This site is on the existing road below GVH-9. The existing road is approximately 16' wide with an average grade of - 8.14%. The road is on native material with ditches and berms for runoff control. This road is scheduled to remain.

GVH-16A - This site will be accessed by a new road constructed from the above referenced road below GVH-9. The new road will be approximately 500' long, 16' wide with an average grade of +8.00%. It will be on native material with runoff control by ditches an/or berms. The new portion of road is scheduled to be removed and reclaimed.

GVH-17 - This site will be accessed from the existing OSO pipeline corridor. The GVH-17 road will be approximately 400' long, 16' wide and have an average grade of -8.00%. It will be on native material with runoff control by ditches and/or berms. This road will be removed and reclaimed when the project is completed.

All roads described above are shown on Figure 1-1 of this Appendix.

## **528 Handling and Disposal of Coal, Excess Spoil, and Coal Mine Waste**

No disposal of coal, excess spoil, and coal mine waste will occur at the well sites.

## **529 Management of Mine Openings**

The perimeter of the sites, including the topsoil stockpiles will be fenced with gates on the access roads. The well casing will have a valve that is closed and locked. The valve will also prevent access by animals or other material. Mine openings will be monitored in accordance with Federal and State Regulations.

During the life of the wells, the sites will be inspected as needed by mine personnel to verify the continued operation of the pumping equipment and general site conditions.

## **530 OPERATIONAL DESIGN CRITERIA AND PLANS**

### **531 General**

This section contains the general plans for the construction of sediment controls and general construction and maintenance of the well sites.

The decision to construct each well will be based on the amount of gas encountered during mining. If small amounts of gas are encountered and the mine's ventilation system can dilute the gob gas, no well will be drilled. The proposed well site locations are shown on Figure 1-1.

### **532 Sediment Control**

Sediment control measures for the well sites are described in Sections 732 and 742 of this submittal. Runoff control structures at the well sites have been designed to convey runoff in a non-erosive manner. Sediment yields in the well permit area are minimized by:

- Disturbing the smallest practicable area during the construction of the well site and
- Contemporaneously reclaiming areas suitable for such reclamation.

### **533 Impoundments**

No impoundments will exist at the well sites.

### **534 Roads**

Refer to Section 527 of this submittal.

### **535 Spoil**

No spoil will be generated at the well sites.

### **536 Coal Mine Waste**

No coal mine waste will be stored at the well sites.

### **537 Regraded Slopes**

#### **537.100 Division Approval**

No mining or reclamation activities will be conducted in the permit area that requires approval of the Division for alternative specifications or for steep cut slopes.

#### **537.200 Regrading of Settled and Revegetated Fills**

Upon completion of the well site, the areas not required for the exhaust blower will be regraded to approximate original contour. Because of the nature of the well site, settling is not anticipated. However, if settlement does occur, these areas will be regraded.

## **540 RECLAMATION PLAN**

### **541 General**

#### **541.100 Commitment**

Upon the permanent cessation of gob gas venting, Andalex Resources, inc. permanently reclaim all affected areas in accordance with the R645 regulations and this reclamation plan.

#### **541.200 Surface Coal Mining and Reclamation Activities**

Not applicable.

#### **541.300 Underground Coal Mining and Reclamation Activities**

Upon completion of the gob gas venting activities the wells will be reclaimed.

#### **541.400 Environmental Protection Performance Standards**

The plan presented is designed to meet the requirements of R645-301 and the environmental protection performance standards of the State Program.

## **542 Narratives, Maps, and Plans**

### **542.100 Reclamation Timetable**

A general timetable for the completion of each major step in the reclamation plan is presented in Figure 5-6.

### **542.200 Plan for Backfilling, Soil Stabilization, Compacting, and Grading**

Following completion of the venting activities, the well site will be prepared for contouring and soil distribution. Details regarding topsoil placement and revegetation are provided in Section 242 and Section 353, respectively.

**Sedimentation Pond Removal and Interim Sediment Control** - See Section 542.500 of this submittal.

### **542.300 Final Surface Configuration Maps and Cross Sections**

The sites will be regraded to the approximate original contour, the contours representing the pre-disturbance topography also represent the reclamation topography. Cross sections representing the final surface configuration will be included upon completion.

### **542.400 Removal of Temporary Structures**

The well sites will not have surface structures.

### **542.500 Removal of Sedimentation Pond**

No sedimentation pond will be constructed at the well sites.

### **542.600 Roads**

The roads which existed prior to the drilling program will be retained after reclamation. The access roads established during the drilling program will be reclaimed after gob gas extraction has been completed. See Section 242 for additional detail concerning the reclamation plan.

### **542.700 Final Abandonment of Mine Openings and Disposal Areas**

All openings will be sealed in accordance with Federal and State Regulations. The casings will be plugged at the bottom to hold concrete. A lean concrete mixture will be poured into the casing until the concrete is within five (5) feet of the surface. At that time the casing will be cut off at ground level and the rest of the casing will be filled with lean concrete. The concrete will be allowed to harden before final reclamation is completed.

## **542.800 Estimated Cost of Reclamation**

Refer to Appendix B of the existing M&RP. It is anticipated that the cost of reclamation of the well sites is adequately covered by the Centennial Project Reclamation Bond. Refer to Chapter 8 for additional detail.

## **550 RECLAMATION DESIGN CRITERIA AND PLANS**

### **551 Casing and Sealing of Underground Openings**

Permanent sealing is described in Section 542.700.

### **552 Permanent Features**

#### **552.100 Small Depressions**

No permanent small depressions will be created as part of the well site construction and reclamation.

#### **552.200 Permanent Impoundments**

See Section 515.200 of this submittal.

### **553 Backfilling and Grading**

#### **553.100 Disturbed Area Backfilling and Grading**

**Approximate Original Contour** - The well sites will be returned to their approximate original contour after reclamation is completed.

**Erosion and Water Pollution** - Sediment controls will consist of gouging the surface to create depressions and mounds which store and impede the movement of water. As vegetation becomes established on the reclaimed surface, erosion potential will be further minimized.

**Post-Mining Land Use** - The disturbed area will be reclaimed in a manner that supports the approved post-mining land use. Refer to Section 411 and 412 for additional detail.



### **553.200 Spoil and Waste**

**Spoil** - No Spoil will be generated within the well sites.

**Coal Processing Waste** - No coal processing waste will be generated within the well sites.

### **553.250 Refuse Piles**

No refuse piles will exist at the well sites.

### **553.300 Exposed Coal Seams, Acid and Toxic Forming Materials and Combustible Materials**

No coal seams will be left exposed at the well sites. All wells will be sealed according to Federal and State regulations.

### **553.400 Cut and Fill Terraces**

No cut and fill terraces will be constructed at the well sites.

### **553.500 Highwall From Previously Mined Areas**

No highwalls exist or will be built at the well sites.

### **553.600 Previously Mined Area**

No previously mined areas exist at the well sites.

### **553.700 Backfilling and Grading - Thin Overburden**

No surface mining and reclamation activities involving thin overburden will occur at the well sites.

### **553.800 Backfilling and Grading - Thick Overburden**

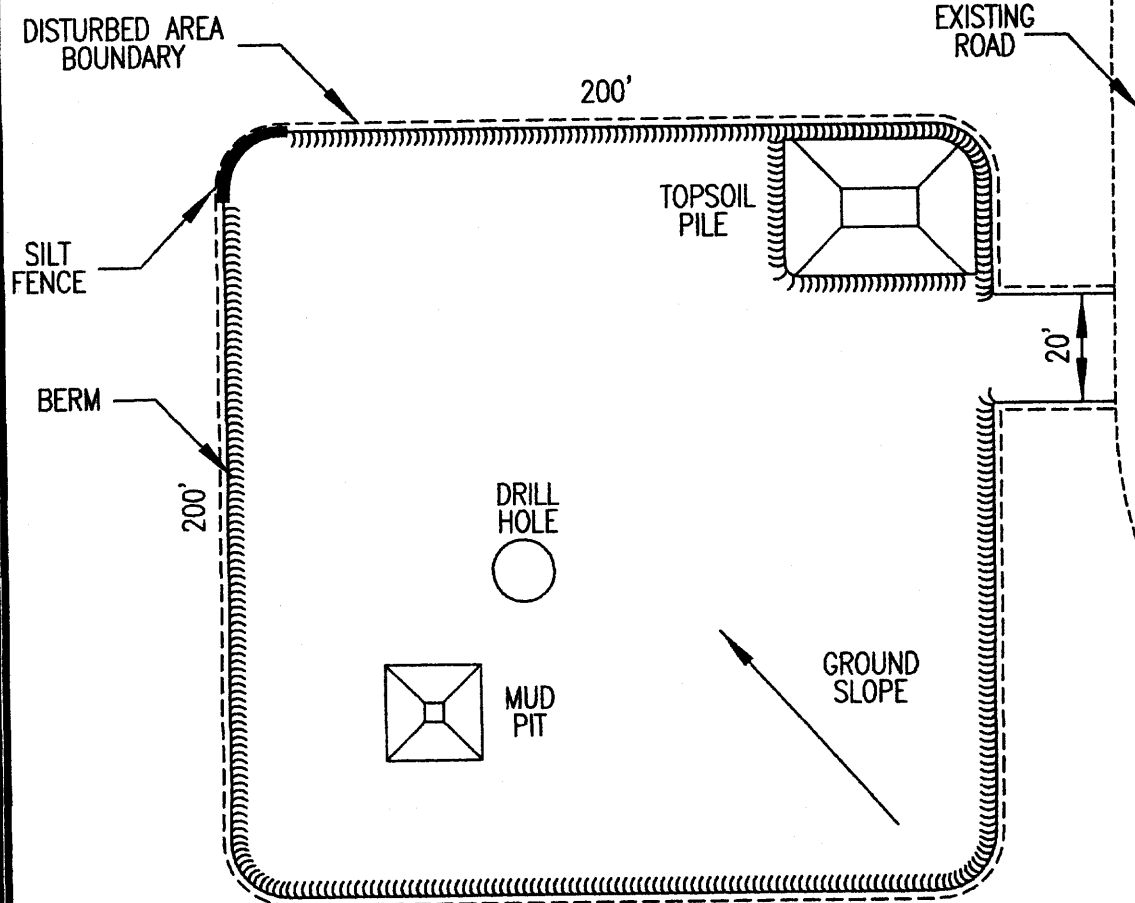
No surface mining and reclamation activities involving thick overburden will occur at the well sites.

### **553.900 Regrading of Settled and Revegetated Rills**

If settlement or rills occur at the well sites, they will be regraded and revegetated. Refer to Section 244.300.

## **560 PERFORMANCE STANDARDS**

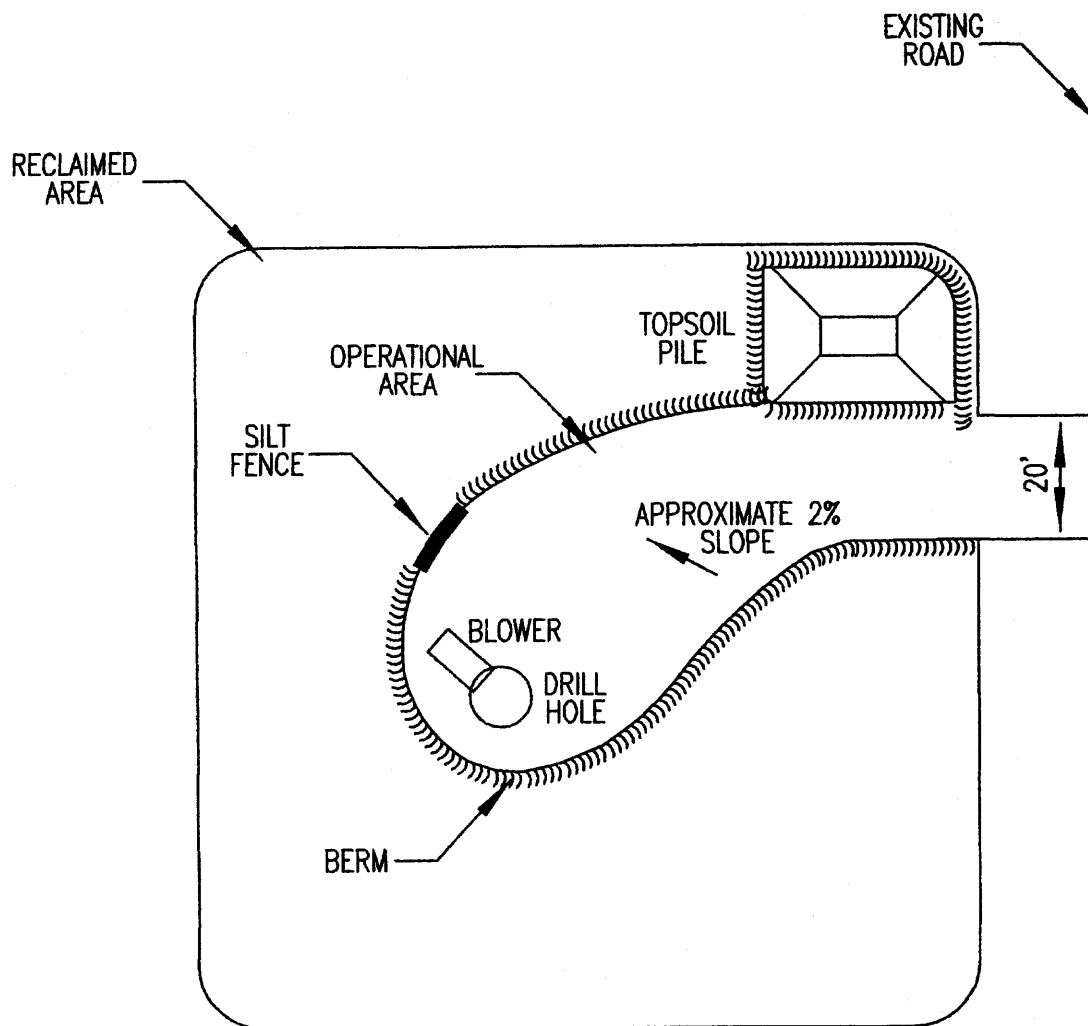
Performance of the well sites will be conducted in accordance with the approved permit and the requirements of R645-301-510 through R645-301-553.



TYPICAL GOB GAS VENT HOLE  
 DRILLING PLAN  
 SCALE: 1" = 50'

FIGURE 5-1

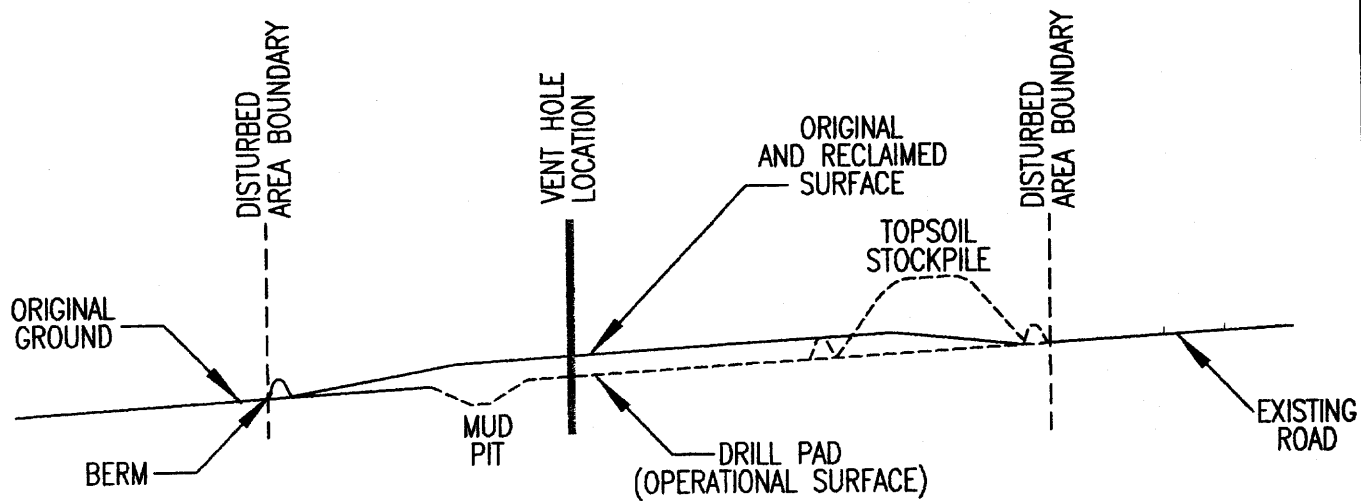




TYPICAL COB GAS VENT HOLE  
OPERATIONAL PLAN  
SCALE: 1"=50'

FIGURE 5-2





TYPICAL GOB GAS VENT HOLE  
PAD CROSS SECTION  
SCALE: 1" = 50'

FIGURE 5-3



# TYPICAL GOB GAS VENT HOLE

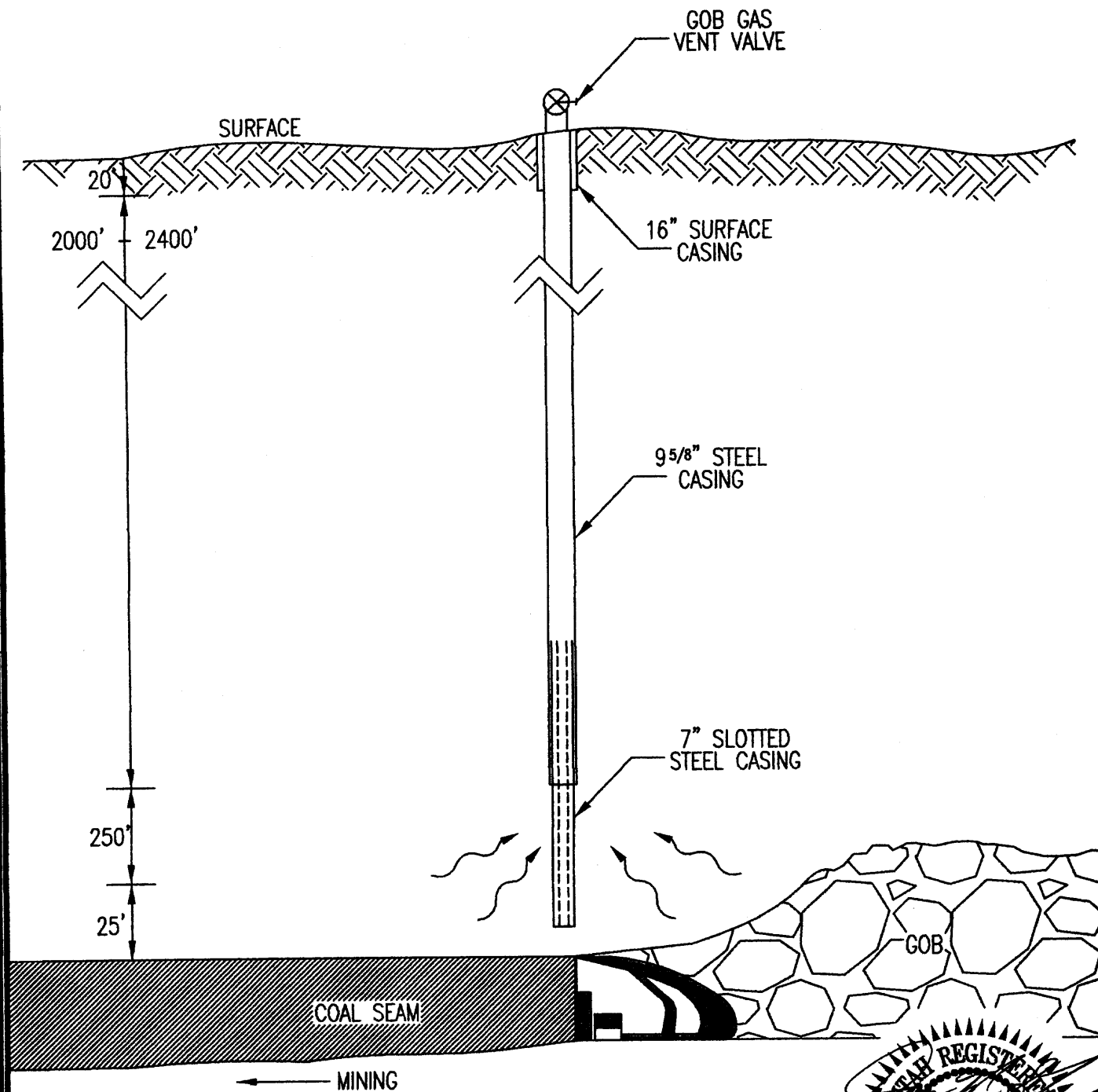


FIGURE 5-4





# TYPICAL ROAD CROSS SECTIONS

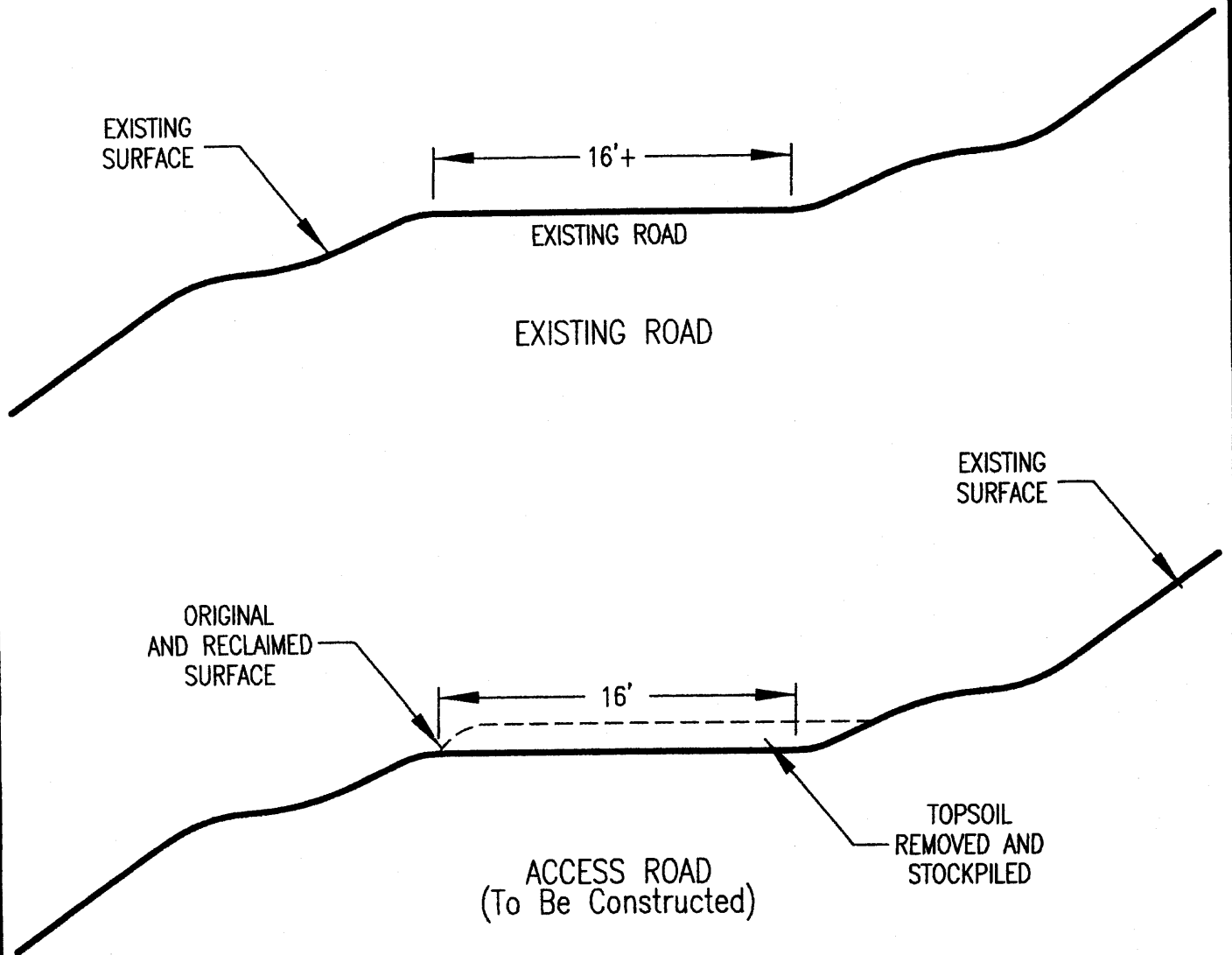


FIGURE 5-5



**PROJECTED GOB GAS VENT HOLE  
RECLAMATION SCHEDULE**

---

**\* CONTEMPORANEOUS RECLAMATION**

1- Regrading	1 Days
2- Ripping	1 Day
3- Spread Topsoil/Roughen	1 Days
4- Re-establish Berms/Drainage Control	1 Days
5- Seed/Mulch	1 Day

Estimated Total Time       -       5 Days

\* After drilling and installation of all operational equipment.

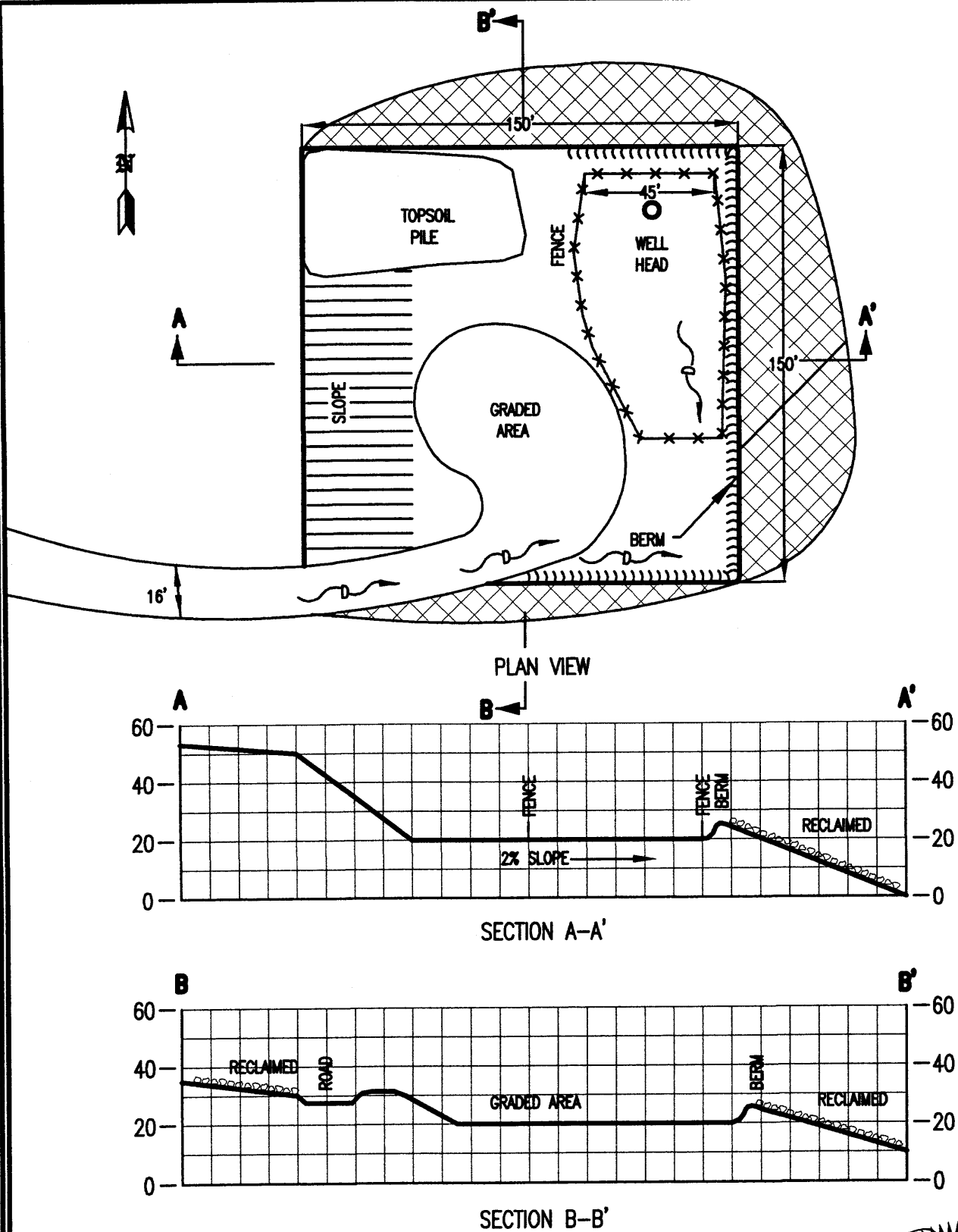
**FINAL RECLAMATION**

1- Structure Removal	1 Days
2- Plug Well	1 Days
3- Regrading	2 Days
4- Ripping	1 Day
5- Topsoil/Roughening	1 Days
6- Seed/Mulch	1 Day

Estimated Total Time       -       7 Days

**FIGURE 5-6**

FIGURE 5-7

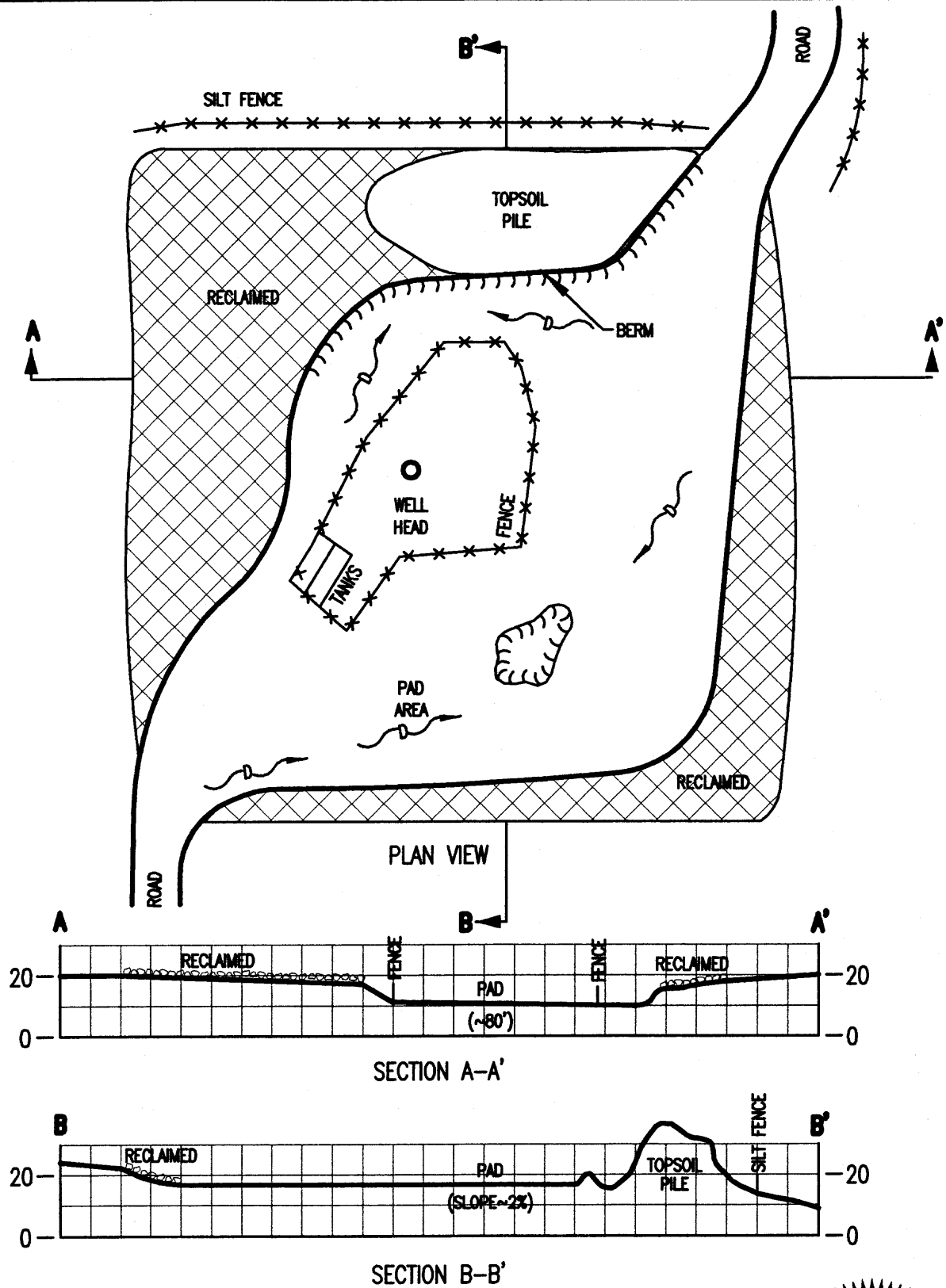


Note: Runoff contained  
by berm.

GVH #1  
As-Constructed  
1" = 50'



FIGURE 5-8

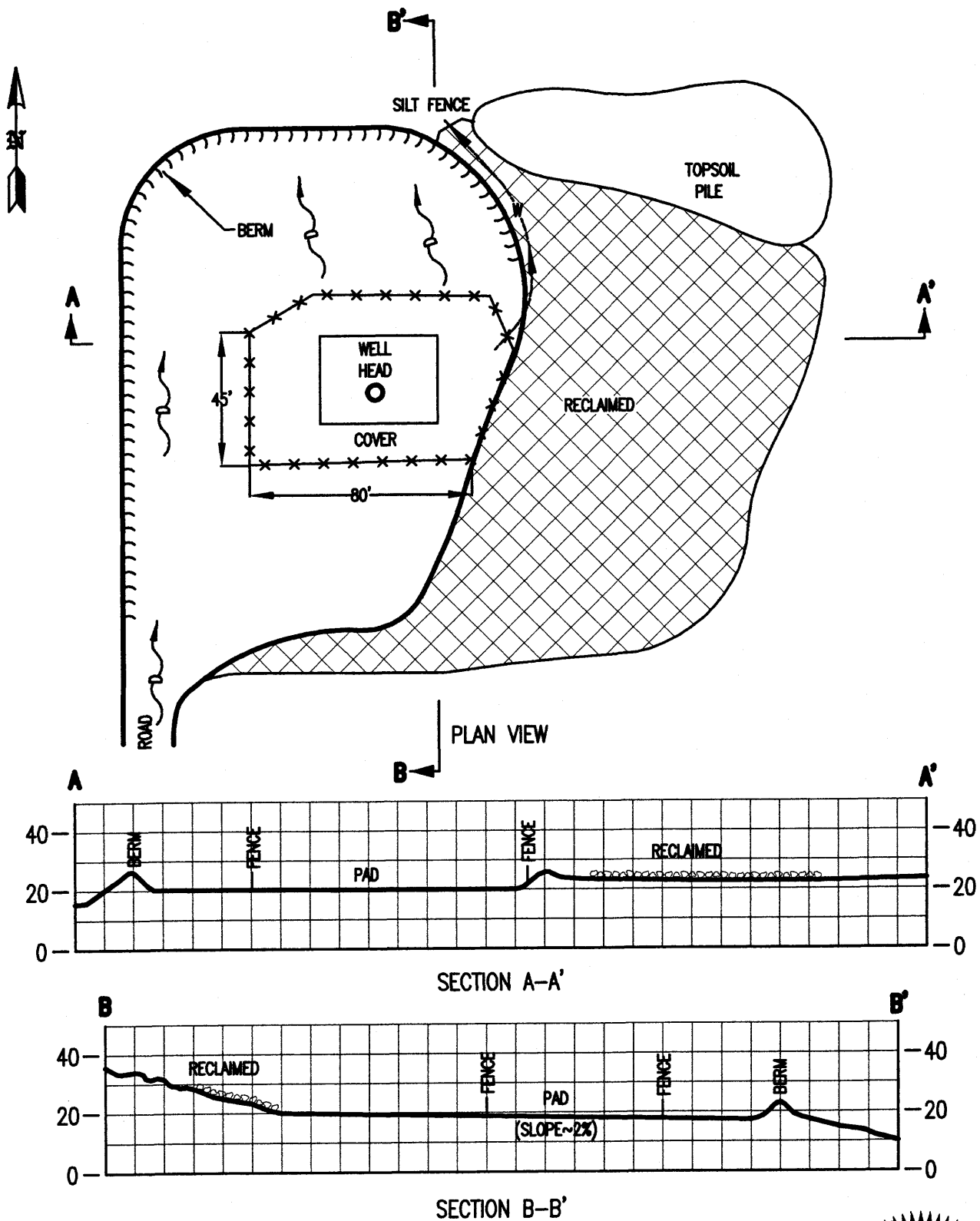


Note: Runoff contained  
by berm.

GVH #3  
As-Constructed  
1" = 50'



FIGURE 5-9

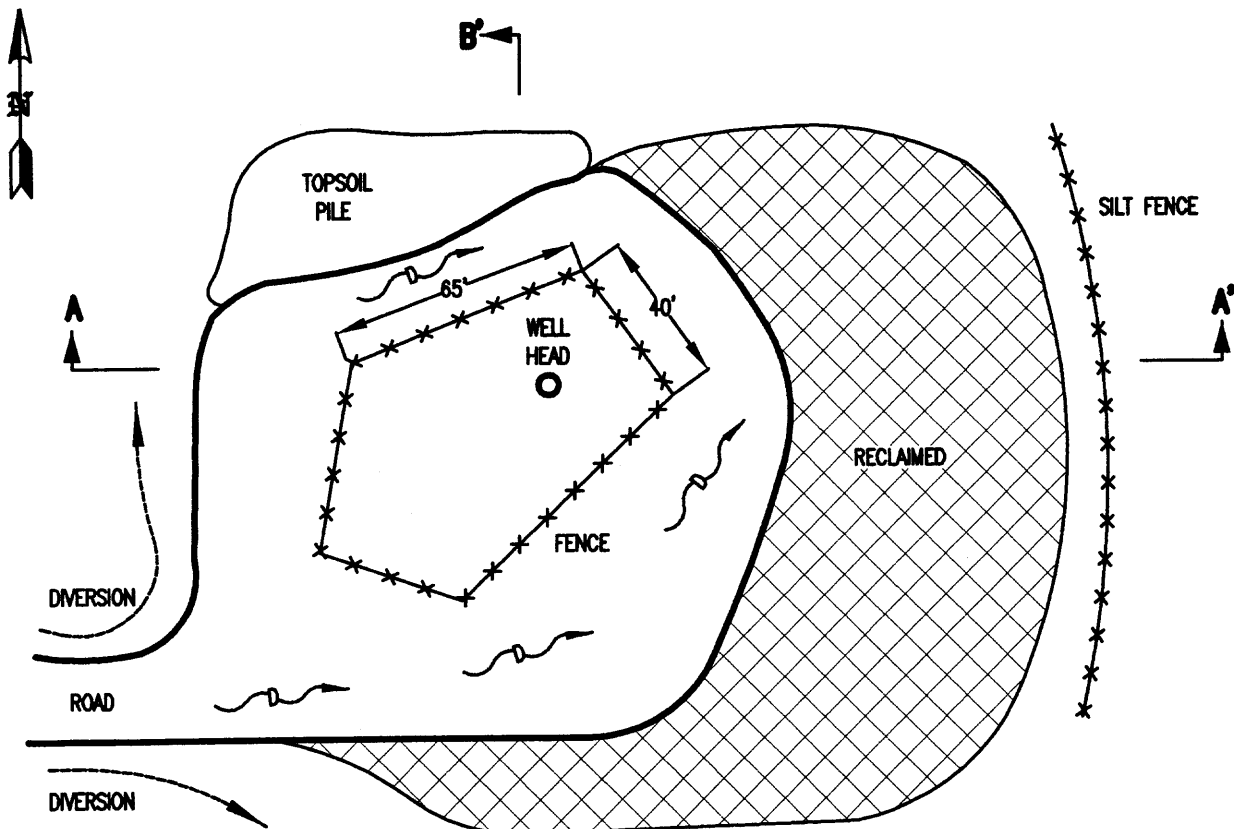


Note: Runoff contained by berm. Water from hole treated by silt fence.

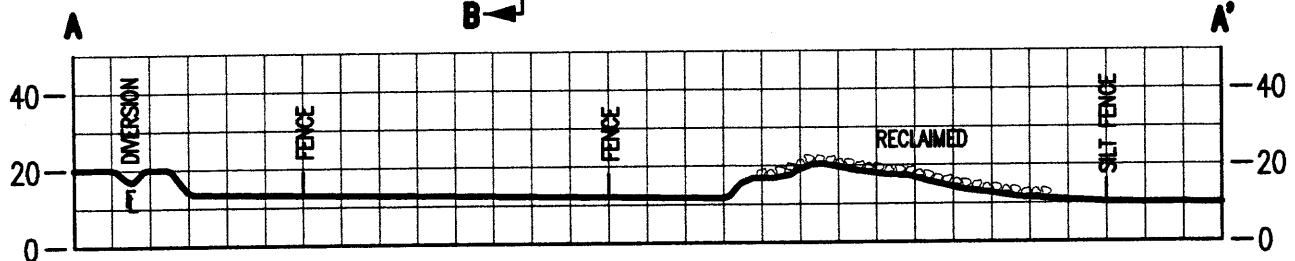
GVH #4  
As-Constructed  
1" = 50'



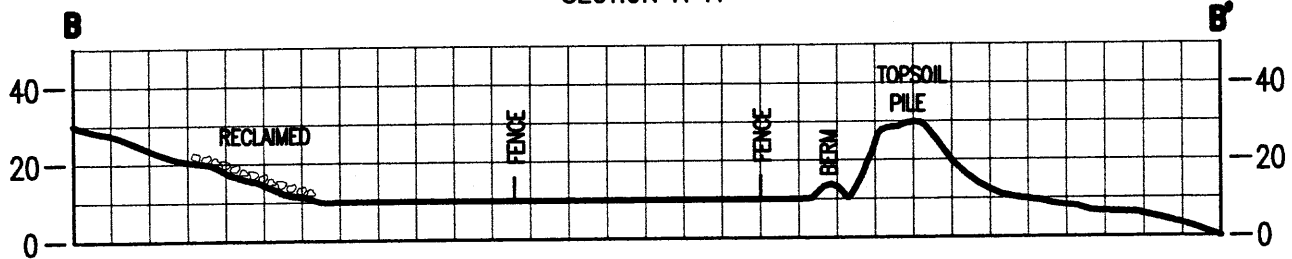
FIGURE 5-10



PLAN VIEW



SECTION A-A'



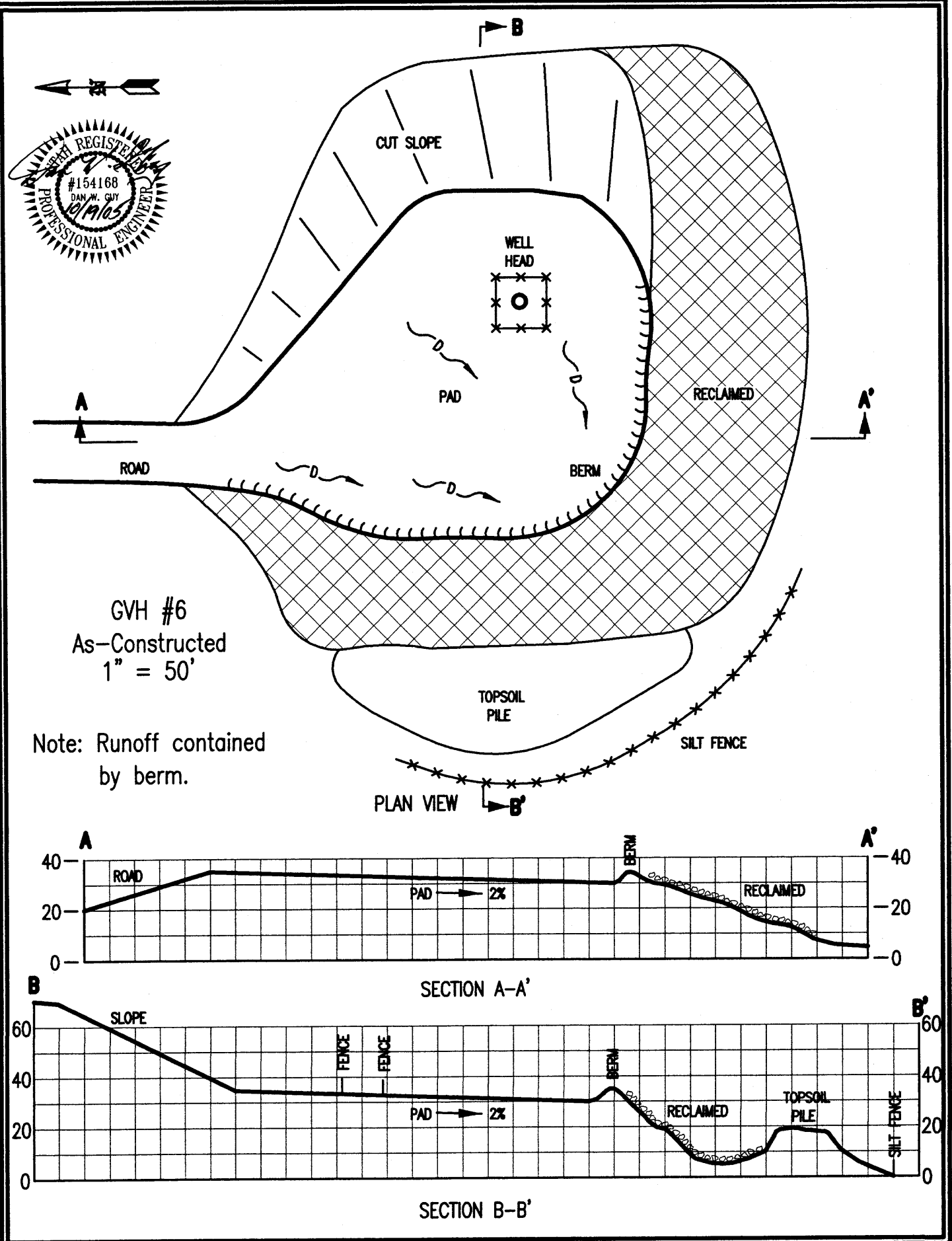
SECTION B-B'

Note: Water from road diverted. Runoff from pad contained by berms.

GVH #5  
As-Constructed  
1" = 50'



FIGURE 5-11





PLAN VIEW

SECTION A-A'

SECTION B-B'

Note: Runoff from pad treated by silt fence.

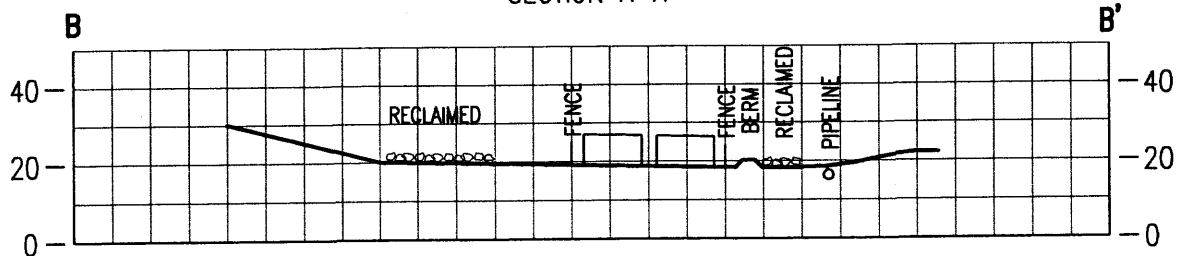
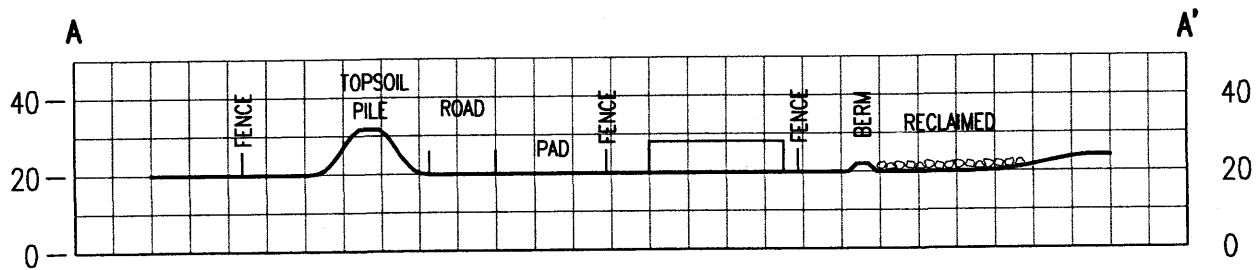
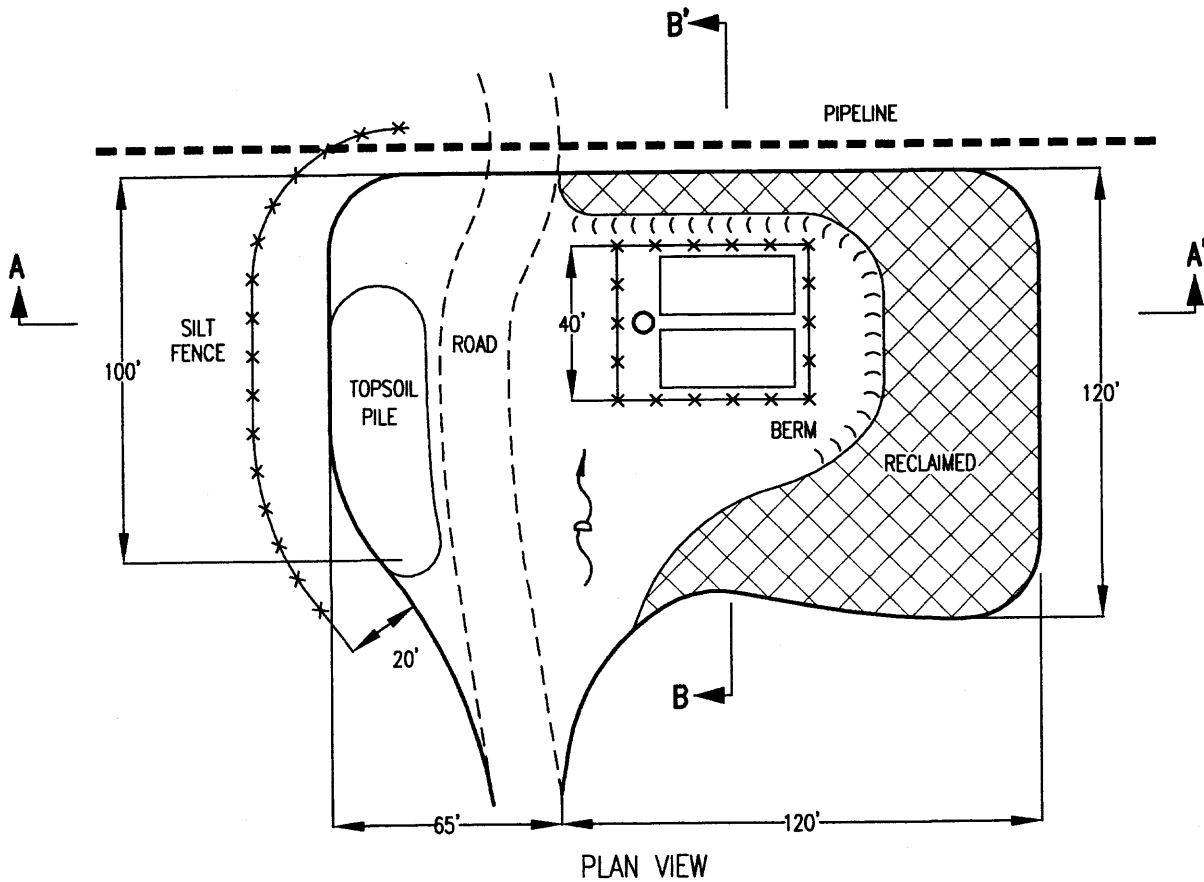
GVH #5A  
As-Constructed  
1" = 50'

PROFESSIONAL ENGINEER  
DAN W. GUY  
#154168  
11/14/06

GVH #5A  
As-Constructed  
1" = 50'



FIGURE 5-13

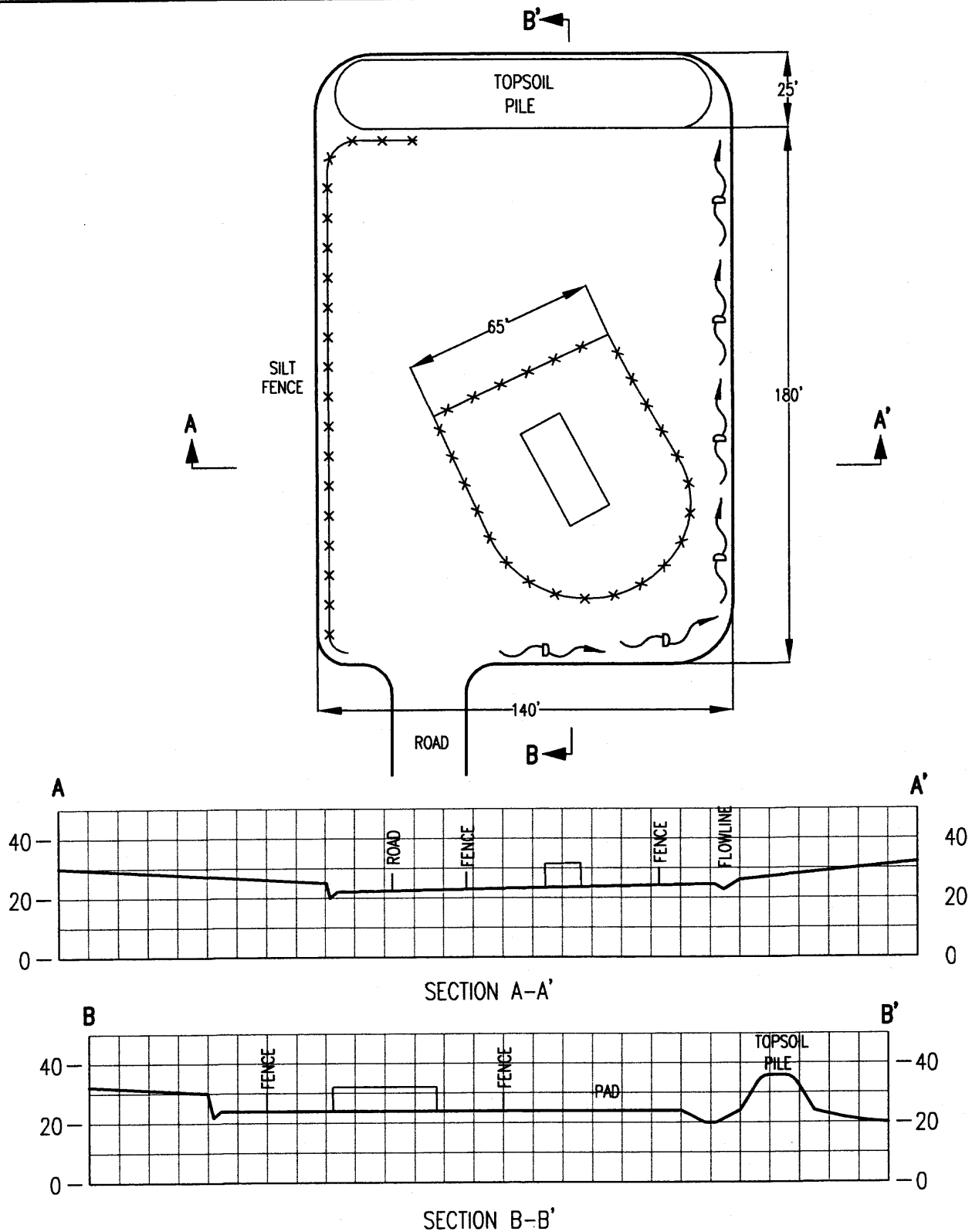


Note: Runoff from pad treated by silt fence.

GVH #7/7A  
As-Constructed  
1" = 50'



FIGURE 5-14



Note: Runoff from pad treated by silt fence.

GVH #8  
As-Constructed  
1" = 50'



FIGURE 5-16

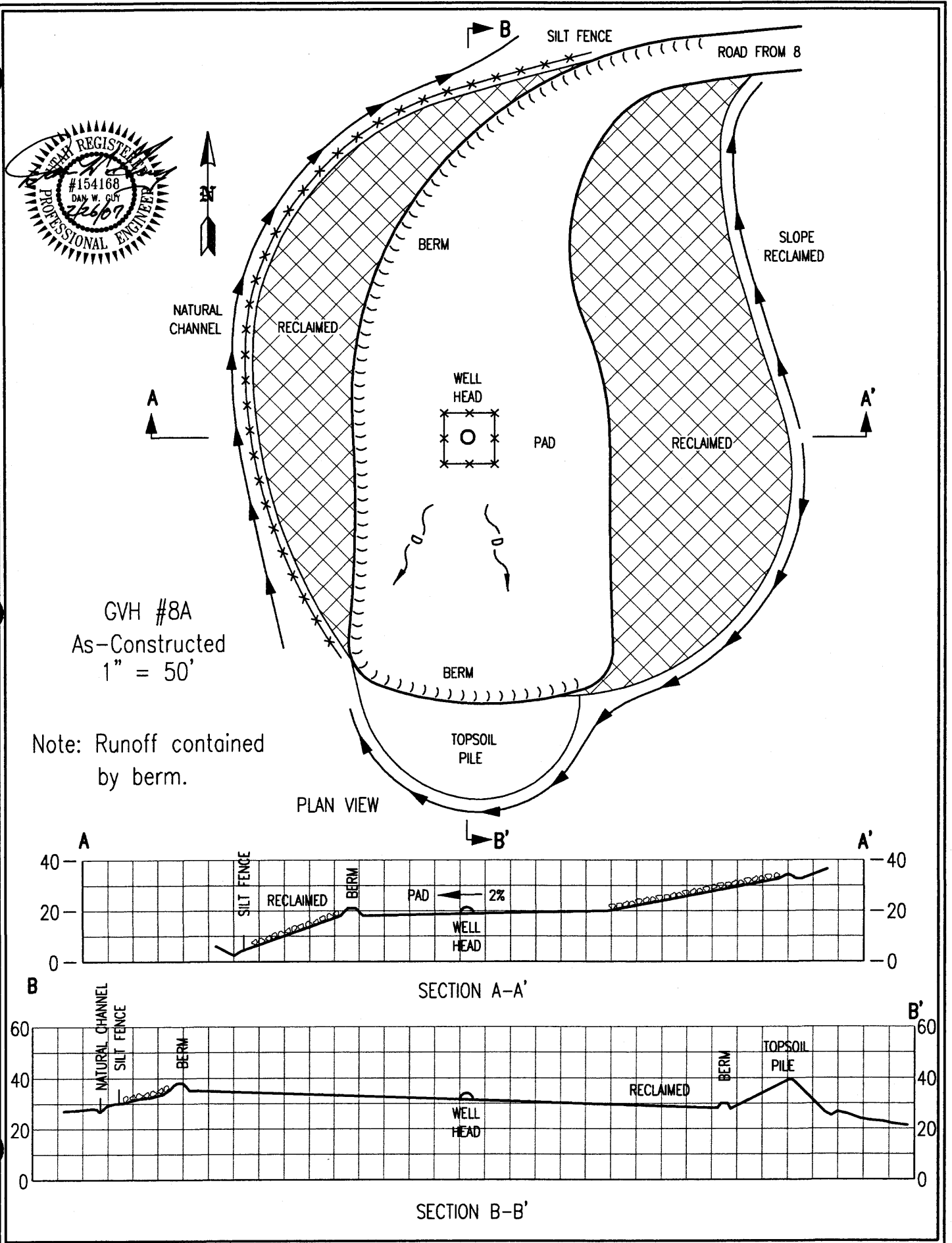
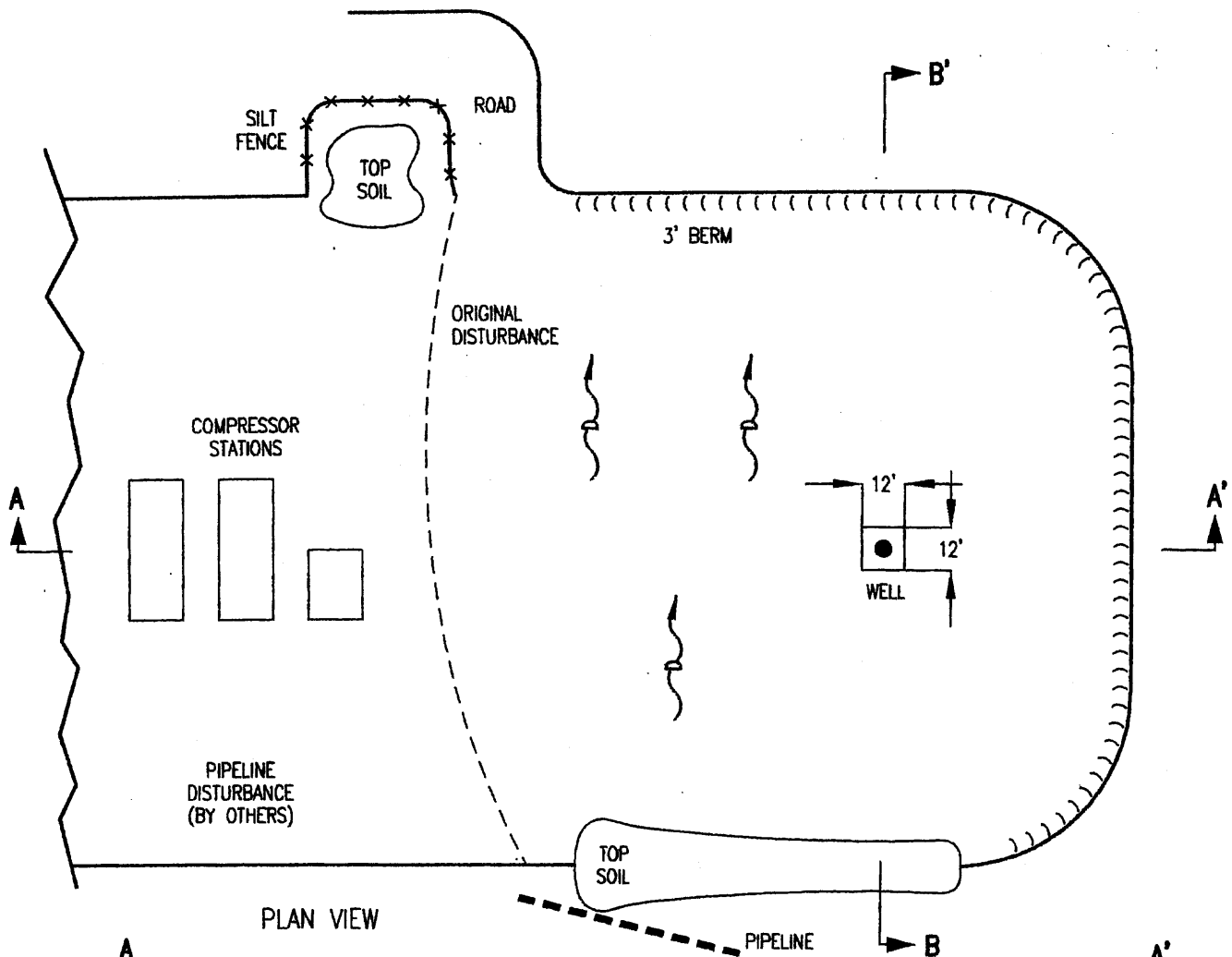
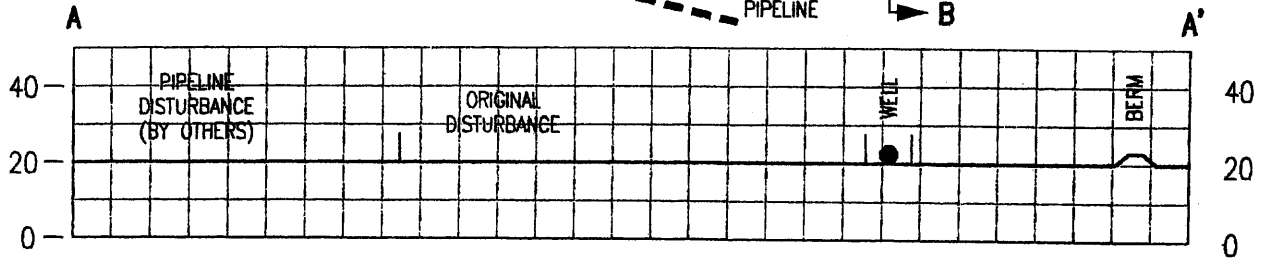


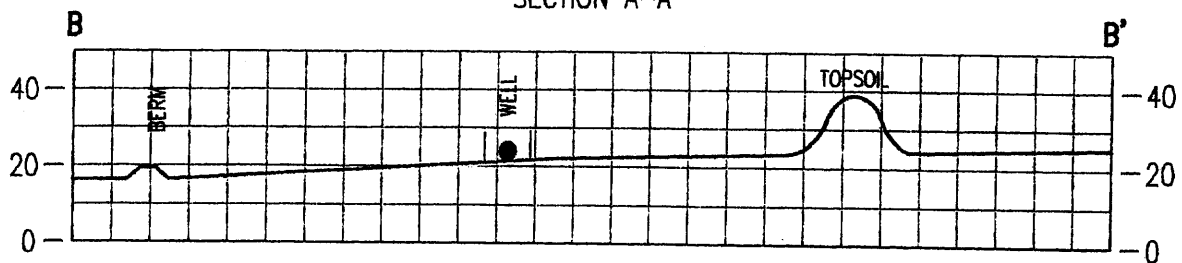
FIGURE 5-15



PLAN VIEW



SECTION A-A'



SECTION B-B'

Note: Runoff contained by berm.

GVH #9  
As-Constructed  
1" = 50'

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(Revised)  
FEBRUARY 2007

**CHAPTER 6**  
**GEOLOGY**

## TABLE OF CONTENTS

<u>Section</u>	<u>Page</u>
610 INTRODUCTION .....	6-1
611 General Requirements .....	6-1
612 Certification .....	6-1
620 ENVIRONMENTAL DESCRIPTION .....	6-1
621 General Requirements .....	6-1
622 Cross Sections, Maps and Plans .....	6-1
623 Geologic Determinations .....	6-1
624 Geologic Information .....	6-1
624.100 Regional Setting .....	6-1
624.200 Test Boring and Drill Hole Data (overburden removed) .....	6-1
624.300 Test Boring and Drill Hole Data (overburden not removed) ...	6-2
625 Additional Geologic Information .....	6-2
626 Sampling Waivers .....	6-2
627 Description of the Overburden Thickness and Lithology .....	6-2
630 OPERATION PLAN	
631 Casing and Sealing of Exploration Holes .....	6-2
632 Subsidence Monitoring .....	6-2
640 PERFORMANCE STANDARDS .....	6-2
641 Exploration and Drill Holes .....	6-2
642 Monuments and Surface Markers of Subsidence Monitoring Points .....	6-2



## **610 INTRODUCTION**

This chapter presents a description of the geologic resources in the area of the Centennial Project. Most of this chapter has been compiled from the approved Geology section of the Centennial Project, Mining and Reclamation Plan.

### **611 General Requirements**

The geologic resources in the Centennial Project area are discussed in Sections 621 through 627 of the M&RP. Information pertaining to the well sites is discussed below.

### **612 Certification**

All maps, plans, and cross-sections presented in this chapter, required by the regulations, have or will have been certified by a professional engineer.

## **620 ENVIRONMENTAL DESCRIPTION**

This section presents a description of the geologic resources in the Centennial Project well site areas.

### **621 General Requirements**

This section presents the regional and site-specific geologic information for the Centennial Project wells sites.

### **622 Cross Sections, Maps and Plans**

Refer to Plate 21 of the approved M&RP for geology associated with the entire permit area, including proposed well site locations.

### **623 Geologic Determinations**

No acid or toxic forming materials will originate at the well sites.

### **624 Geologic Information**

#### **624.100 Regional Setting**

Refer to Section 624 of the approved M&RP.

#### **624.200 Test Boring and Drill Hole Data (overburden removed)**

No test boring or drill cores are planned at the well sites.

### **624.300 Test Boring and Drill Hole Data (overburden not removed)**

No test boring or drill cores are planned at the well sites.

#### **625 Additional Geologic Information**

It is not anticipated that any additional geologic data will need to be collected at the well sites.

#### **625 Sampling Waivers**

A sampling waiver is not requested at this time for the well sites.

#### **627 Description of the Overburden Thickness and Lithology**

Not applicable to this amendment.

### **630 OPERATIONAL PLAN**

#### **631 Casing and Sealing of Exploration Holes**

Not applicable to this amendment.

#### **632 Subsidence Monitoring**

See Section 525 for additional information

### **640 PERFORMANCE STANDARDS**

#### **641 Exploration and Drill Holes**

The performance standards used in the casing and sealing of all exploration holes and drill holes are outlined in the approved M&RP, Section 542.700.

#### **642 Monuments and Surface Markers of Subsidence Monitoring Points**

The performance standards used in the reclamation of all monuments and surface markers used in subsidence monitoring points are outlined in the approved M&RP, Section 525.

(Revised)  
FEBRUARY 2007

**CHAPTER 7**  
**HYDROLOGY**

## TABLE OF CONTENTS

<u>Section</u>	<u>Page</u>
710 INTRODUCTION .....	7-1
711 General Requirements .....	7-1
712 Certification .....	7-1
713 Inspection .....	7-1
720 ENVIRONMENTAL DESCRIPTION .....	7-1
721 General Requirements .....	7-1
722 Cross Sections and Maps .....	7-2
722.100 Location and Extent of Subsurface Water .....	7-2
722.200 Location of Surface Water Bodies .....	7-2
722.300 Locations of Monitoring Stations .....	7-2
722.400 Locations and Depth of Water Wells .....	7-2
722.500 Surface Topography .....	7-2
723 Sampling and Analysis .....	7-2
724 Baseline Information .....	7-2
724.100 Groundwater Information .....	7-2
724.200 Surface Water Information .....	7-2
724.300 Geologic Information .....	7-3
724.400 Climatological Information .....	7-3
724.500 Supplemental Information .....	7-3
724.600 Survey of Renewable Resource Lands .....	7-3
724.700 Alluvial Valley Floor Requirements .....	7-3
725 Baseline Cumulative Impact Area Information .....	7-3
726 Modeling .....	7-3
727 Alternate Water Source Information .....	7-3

## TABLE OF CONTENTS (Continued)

<u>Section</u>	<u>Page</u>
<b>728 Probable Hydrologic Consequences</b> .....	7-3
728.100 Potential Impacts of Surface and Groundwater .....	7-4
728.200 Baseline Hydrologic and Geologic Information .....	7-4
728.300 PHC Determination .....	7-4
<b>729 Cumulative Hydrologic Impact Assessment (CHIA)</b> .....	7-5
<b>730 OPERATION PLAN</b> .....	7-5
<b>731 General Requirements</b> .....	7-5
731.100 Hydrologic - Balance Protection .....	7-5
731.200 Water Monitoring .....	7-5
731.300 Acid or Toxic Forming Materials .....	7-5
731.400 Transfer of Wells .....	7-5
731.500 Discharge .....	7-6
731.600 Stream Buffer Zone .....	7-6
731.700 Cross Section and Maps .....	7-6
731.800 Water Rights and Replacement .....	7-6
<b>732 Sediment Control Measures</b> .....	7-6
732.100 Siltation Structures .....	7-6
732.200 Sedimentation Pond .....	7-6
732.300 Diversions .....	7-6
732.400 Road Drainage .....	7-7
<b>733 Impoundments</b> .....	7-7
733.100 General Plans .....	7-7
733.200 Permanent and Temporary Impoundments .....	7-7
<b>734 Discharge Structures</b> .....	7-7
<b>735 Disposal of Excess Spoil</b> .....	7-7
<b>736 Coal Mine Waste</b> .....	7-7
<b>737 Non-Coal Mine Waste</b> .....	7-7

## TABLE OF CONTENTS (Continued)

<u>Section</u>	<u>Page</u>
738 Temporary Casing and Sealing of Wells .....	7-7
740 DESIGN CRITERIA AND PLANS .....	7-8
741 General Requirements .....	7-8
742 Sediment Control Measures .....	7-8
742.100 General Requirements .....	7-8
742.200 Siltation Structures .....	7-8
742.300 Diversions .....	7-8
742.400 Road Drainage .....	7-8
743 Impoundments .....	7-8
744 Discharge Structures .....	7-8
745 Disposal of Excess Spoil .....	7-9
746 Coal Mine Waste .....	7-9
746.100 General Requirements .....	7-9
746.200 Refuse Piles .....	7-9
746.300 Impounding Structures .....	7-9
746.400 Return of Coal Processing Waste to Abandoned Underground Workings .....	7-9
747 Disposal of Non-Coal Waste .....	7-9
748 Casing and Sealing Wells .....	7-9
750 PERFORMANCE STANDARDS .....	7-9
751 Water Quality Standards and Effluent Limitations .....	7-9
752 Sediment Control Measures .....	7-9
752.100 Siltation Structures and Diversions .....	7-10
752.200 Road Drainage .....	7-10

## TABLE OF CONTENTS (Continued)

<u>Section</u>	<u>Page</u>
753 Impoundments and Discharge Structures .....	7-10
754 Disposal of Excess Spoil, Coal Mine Waste and Non-Coal Mine Waste .....	7-10
755 Casing and Sealing .....	7-10
760 RECLAMATION .....	7-10
761 General Requirements .....	7-10
762 Roads .....	7-10
762.100 Restoring the Natural Drainage Patterns .....	7-10
762.200 Reshaping Cut and Fill Slopes .....	7-10
763 Siltation Structures .....	7-11
763.100 Maintenance of Siltation Structures .....	7-11
763.200 Removal of Siltation Structures .....	7-11
764 Structure Removal .....	7-11
765 Permanent Casing and Sealing of Wells .....	7-11

### List of Attachments

Attachment 7-1      Hydrology Calculations



## **710 INTRODUCTION**

### **711 General Requirements**

This chapter presents a description of the following:

- Proposed operations and the potential impacts to the hydrologic balance;
- Methods of compliance with design criteria and the calculations utilized to show compliance; and
- Applicable hydrologic performance standards.

As-constructed drawings are provided for completed sites in Figures 5-7 through 5-15. Hydrology calculations are provided in Attachment 7-1.

### **712 Certification**

All required maps, plans, and cross sections presented in this chapter have been or will be certified by a qualified, registered professional engineer.

### **713 Inspection**

Inspections are not required since no permanent impoundments will exist at the well sites.

## **720 ENVIRONMENTAL DESCRIPTION**

### **721 General Requirements**

This section presents a description of the pre-mining hydrologic resources within the well pad and their adjacent areas that may be affected or impacted by the proposed coal mining and reclamation operations.

Completed holes are GVH#1, GVH#3, GVH#4, GVH#5, GVH#5A, GVH#6, GVH#7, GVH#7A, GVH#8, GVH#8A, and GVH#9. The following is a list of holes proposed for approval - GVH#10, GVH#10A, GVH#11, GVH#11A, GVH#12, GVH#12A, GVH#13, GVH#13A, GVH#14, GVH#14A, GVH#15, GVH#15A, GVH#16, GVH#16A and GVH#17. All holes are shown on Figure 1-1.

Due to required changes in the mining plan, hole GVH#5B will not be drilled and has been shown as eliminated, although the site has been approved and included in the bonding.

## **722 Cross Sections and Maps**

### **722.100 Location and Extent of Subsurface Water**

Section 724 of the approved M&RP provides baseline information. Appendix L of the M&RP includes Surface and Ground Water Inventories.

### **722.200 Location of Surface Water Bodies**

Figures 4 & 5 in the approved M&RP (Appendix L: Surface and Groundwater Hydrologic Inventory) show the locations of the surface-water bodies and existing or pending water rights. Section 724.200 of the approved M&RP provides baseline surface water conditions.

### **722.300 Locations of Monitoring Stations**

Figure 6 and IV-II in the approved M&RP (Appendix L: Surface and Groundwater Hydrologic Inventory) shows the location of surface water and groundwater monitoring stations.

### **722.400 Locations and Depth of Water Wells**

Refer to Section 722.400 of the approved M&RP for information pertaining to the groundwater monitoring wells.

### **722.500 Surface Topography**

Surface topography features at the well sites and adjacent areas are shown on Figure 1-1.

## **723 Sampling and Analysis**

Refer to Section 723 of the approved M&RP.

## **724 Baseline Information**

Refer to Section 724 of the approved M&RP.

### **724.100 Groundwater Information**

Refer to Section 724.100 of the approved M&RP.

### **724.200 Surface Water Information**

Refer to Section 724.200 of the approved M&RP.

### **724.300 Geologic Information**

Geologic information related to the well sites and adjacent areas is presented in Chapter 6 of this submittal and in the approved M&RP.

### **724.400 Climatological Information**

Climatological information is provided in Section 724.400 of the approved M&RP.

### **724.500 Supplemental Information**

Refer to Section 724.500 of the approved M&RP.

### **724.600 Survey of Renewable Resource Lands**

Refer to Section 724.600 of the approved M&RP.

### **724.700 Alluvial Valley Floor Requirements**

Information provided in Appendix L of the M&RP shows this area does not meet requirements for Alluvial Valley Floors.

## **725 Baseline Cumulative Impact Area Information**

The CHIA currently in place for the Centennial Project covers the well sites. The hydrologic and geologic information required for the Division to develop a Cumulative Hydrologic Impact Assessment (CHIA) is presented in the approved M&RP.

## **726 Modeling**

No groundwater or surface water modeling was conducted in support of this submittal

## **727 Alternative Water Source Information**

Not applicable.

## **728 Probable Hydrologic Consequences**

This section addresses the probable hydrologic consequences of construction and reclamation operations at the well sites. Mitigation measures are discussed generally in this section and in detail in Section 730 of the approved M&RP.

### **728.100 Potential Impacts of Surface and Groundwater**

Potential impacts of the well sites in this area on the quality and quantity of surface and groundwater flow may include contamination from materials associated with the drilling of the wells. The potential impact is addressed in Section 728.300 of this submittal.

### **728.200 Baseline Hydrologic and Geologic Information**

Baseline geologic information is presented in Chapter 6 of the approved M&RP. Baseline hydrologic information is presented in Section 724.100 and 724.200 of the approved M&RP.

### **728.300 PHC Determination**

**Potential Impacts to the Hydrologic Balance** - Potential impacts of the Centennial Project on the hydrologic balance of the well sites and adjacent areas are addressed in the subsections of this submittal and the approved M&RP.

**Acid and Toxic Forming Materials** - No acid or toxic forming materials have been identified in the soils or strata of the Centennial Project (Chapter 6, Section 623 of this submittal). Additional information is located in Appendix E of the approved M&RP.

**Groundwater** - During drilling of the wells, the groundwater encountered will be affected. Drilling mud will be used to seal the groundwater aquifers. Once drilling is completed, the casing will be grouted in the well hole. This will seal the aquifers to prevent any groundwater from migrating down the outside of the casing into the mine.

**Potential Hydrocarbon Contamination** - Hydrocarbon products will not be stored at the well sites, however fuels, greases, and other oils may leak from equipment during drilling operations. Absorbent materials will be used for the collection of leaked fuels, greases, and other oils. The saturated absorbent materials will be disposed of at an appropriate landfill facility.

### **729 Cumulative Hydrologic Impact Assessment (CHIA)**

The Cumulative Hydrologic Impact Assessment currently in place for the Centennial Project includes the well sites and adjacent areas.

## **730 OPERATION PLAN**

### **731 General Requirements**

#### **731.100 Hydrologic - Balance Protection**

**Groundwater Protection** - The effect on groundwater at the well sites is expected to be minimal. Groundwater encountered during drilling will be sealed off, refer to Section 728.300.

**Surface Water Protection** - To protect the hydrologic balance, construction, maintenance, and reclamation operations will be conducted to handle earth materials and runoff in a manner that prevents, to the extent possible, additional contributions of suspended solids to stream flow outside the permit are, and otherwise prevent water pollution.

During initial drilling, the sites will be graded to ensure that storm runoff will flow towards the berms surrounding the entire drilling pad area. The berms will direct the runoff to the lowest point(s) within the pad area where a silt fence and/or straw bale dike(s) will treat the runoff. The berm placed at the top of the drilling pad cut slopes will divert runoff around the drilling pad. Thus reducing the runoff affected by the drilling pad.

After drilling, the pad size will be reduced for exhausting operations. The pad will be re-graded to cause the storm runoff to sheet flow towards a silt fence and/or straw bale dike. A berm will be placed at the top of the fill slope to direct any runoff from the operational pad to the silt fence and/or straw bale dike. The silt fences and/or straw bale dikes will be periodically inspected, and accumulated sediment will be removed as needed to maintain functionality. The sediment from the silt fence and/or straw bale dikes will be piled on the pad and will be used for fill during final reclamation of the well site. During the drilling phase a berm and silt fence will be installed at the toe of the fill slope to treat any runoff from the drilling pad. During the operational phase there will still be sediment control (silt fence) at the toe of the slope

#### **731.200 Water Monitoring**

No water monitoring will be conducted at the degas well sites. Refer to approved M&RP for a description of water monitoring.

#### **731.300 Acid or Toxic Forming Materials**

No acid or toxic forming materials are anticipated at the well sites. (see Section 728.300).

#### **731.400 Transfer of Wells**

Refer to Section 731.400 of the approved M&RP.

### **731.500 Discharge**

No discharge to underground workings.

### **731.600 Stream Buffer Zones**

**Stream Channel Diversions** - No stream channel diversions are planned at the well sites.

**Buffer Zone Designation** - None of the drilling sites are adjacent to a stream, therefore the establishment of a stream buffer zone is not necessary.

### **731.700 Cross Section and Maps**

Not applicable.

### **731.800 Water Rights and Replacement**

Refer to Sections 728.300 and 731.800 of the approved M&RP.

## **732 Sediment Control Measures**

The sediment control measures within the well sites have been designed to prevent additional contributions of sediment to stream flow or to runoff outside the well sites. In addition, the well sites have been designed to minimize erosion to the extent possible.

The structures to be used for runoff control at the well sites are berms, silt fences and/or straw bale dikes. Please refer to the drawings previously provided with this Appendix (5-1, 5-2, 5-3, 5-4 and 5-5), and new As-Constructed drawings 5-7 through 5-15, found at the end of Chapter 5. These drawings show slope and location of sedimentation structures (silt fences, berms).

### **732.100 Siltation Structures**

Berms, silt fences and straw bales dikes will be used to treat runoff.

### **732.200 Sedimentation Pond**

The drilling sites will not have sedimentation ponds.

### **732.300 Diversions**

Refer to Section 731.100 of this submittal.

### **732.400 Road Drainage**

No diversion ditches will be constructed along the roads leading to the well sites. See Figure 5-5 for typical road cross section. Where needed roads accessing the drill sites will have a water bar constructed at the base of the road to divert water off the road prior to the runoff reaching the drill pad. The existing access road up Deadman Canyon to the locations will be equipped with silt fences in the Spring/Summer of 2005 to help control sediment. In addition to the water bars mentioned, 18-24 inch culverts will be installed on this private road and left in place at the owner's request.

### **733 Impoundments**

#### **733.100 General Plans**

Not applicable.

#### **733.200 Permanent and Temporary Impoundments**

No permanent impoundments will exist at the well sites.

### **734 Discharge Structures**

A berm will surround the entire drill pad at each well site during the drilling phase. The berm will divert undisturbed runoff around the drilling pad and direct runoff from the pad to a silt fence/straw bale dike at the lowest point within the well pad disturbed area. A silt fence and/or straw bale dike will be the discharge structure for each of the well sites during the operational phase.

### **735 Disposal of Excess Spoil**

There will be no excess spoil generated at the well sites.

### **736 Coal Mine Waste**

There will be no coal mine waste generated or stored at the well sites.

### **737 Non-Coal Mine Waste**

There will be no non-coal mine waste disposal at the well site.

### **738 Temporary Casing and Sealing of Wells**

Refer to Section 542.700 of this submittal.



## **740 DESIGN CRITERIA AND PLANS**

### **741 General Requirements**

This submittal includes general well site plans that incorporate design criteria for the control of drainage.

### **742 Sediment Control Measures**

#### **742.100 General Requirements**

**Design** - Sediment control measures have been formulated to prevent additional contributions of sediment to stream flow or to runoff outside the well site area; and minimize erosion to the extent possible.

**Measures and Methods** - Sediment control methods will include sit fence, berms, and straw bales to reduce runoff and trap sediment.

#### **742.200 Siltation Structures**

**General Requirements** - Additional contributions of suspended solids and sediment or runoff outside the well site area will be prevented to the extent possible using silt fence, berms, and straw bale dikes. Siltation structures (berms, silt fences and/or straw bale dikes) will be installed before the topsoil is removed from the well site. Construction activities will not occur during major precipitation events.

**Design** - All hydrology calculations will be made using the 10-year, 24-hour precipitation event. Hydrology calculations are included in Attachment 7-1.

#### **742.300 Diversions**

No diversion ditches will be constructed as part of the drilling or operational phases.

#### **742.400 Road Drainage**

Refer to Section 732.400 of this submittal.

### **743 Impoundments**

No impoundments will exist at the wells sites.

### **744 Discharge Structures**

No discharge structures have been planned or designed.

#### **745 Disposal of Excess Spoil**

There will be no excess spoil generated at the well sites.

#### **746 Coal Mine Waste**

##### **746.100 General Requirements**

There will be no coal mine waste used at the well sites.

##### **746.200 Refuse Piles**

There will be no refuse piles at the well sites.

##### **746.300 Impounding Structures**

Refer to Section 733.200 of this submittal.

##### **746.400 Return of Coal Processing Waste to Abandoned Underground Workings**

No coal processing waste will be generated at the well sites.

#### **747 Disposal of Non-Coal Mine Waste**

All non-coal mine waste will be disposed of at an approved landfill.

#### **748 Casing and Sealing Wells**

Refer to Section 542.700 of this submittal.

### **750 PERFORMANCE STANDARDS**

#### **751 Water Quality Standards and Effluent Limitations**

Water encountered during drilling and runoff water will be treated using silt fence and/or straw bale dikes prior to leaving the site. Should it become necessary the water encountered during drilling will be pumped into a tank and hauled from the site for disposal at a licensed facility.

#### **752 Sediment Control Measures**

All sediment control measures will be located, maintained, constructed and reclaimed according to plans and designs presented in Section 732, 742, and 760 of this submittal.

### **752.100 Siltation Structures and Diversions**

Siltation structures will be located, maintained, constructed and reclaimed according to plans and designs presented in Section 732, 742, and 763 of this submittal.

### **752.200 Road Drainage**

Refer to Section 732.400 of this submittal.

### **753 Impoundments and Discharge Structures**

Refer to Section 733.200 of this submittal.

### **754 Disposal of Excess Spoil, Coal Mine Waste and Non-Coal Mine Waste**

There will be no excess spoil or coal mine waste generated at the well sites. Refer to Section 747 of this submittal regarding non-coal waste disposal.

### **755 Casing and Sealing**

Refer to Section 542.700 of this submittal.

## **760 RECLAMATION**

### **761 General Requirements**

A detailed reclamation plan for the well sites is presented in Section 540. No structures will exist at the well sites.

### **762 Roads**

Refer to Section 542.600.

#### **762.100 Restoring the Natural Drainage Patterns**

The natural drainage patterns will be restored after degassification is completed.

#### **762.200 Reshaping Cut and Fill Slopes**

Cut and fill slopes will be reshaped at the well sites.

## **763 Siltation Structures**

### **763.100 Maintenance of Siltation Structures**

All siltation structures will be maintained until removed in accordance with the approved reclamation plan.

### **763.200 Removal of Siltation Structures**

When a siltation structure is removed, the land on which the siltation structure was located will be regraded and revegetated in accordance with the reclamation plan presented in Section 540.

## **764 Structure Removal**

A general timetable for the reclamation of the sites is presented in Figure 5-6.

## **765 Permanent Casing and Sealing of Wells**

Refer to Section 542.700 of this submittal.

**ATTACHMENT 7-1  
HYDROLOGY CALCULATIONS**



## HYDROLOGY CALCULATIONS

General - The potential runoff for each of the Gob Gas Vent Hole sites is calculated using the 10 year - 24 hour precipitation event of 1.82" and other criteria as described in the approved M.R.P. Section R645-301-512.240.

Runoff and controls for completed sites are based on existing sizes and conditions. Contemporaneously reclaimed areas have been mulched and roughened, seeded, and protected by silt fences as needed, and are therefore considered adequate for runoff protection and control.

Proposed sites are based on the projected original disturbed area size of approximately 1.0 acre, with a length of 200' and a slope of 2%.

Runoff protection and control for all sites is primarily through total containment by berms; however, silt fences are used as needed to provide additional protection below slope areas.

The following is a summary of runoff calculations for the existing as well as the proposed gob gas vent holes, along with controls and treatment of runoff.

GVH Runoff Summary					
Hole	Status	Disturbed Area (ac.)	Peak Flow (cfs)	Runoff Volume (ac. ft.)	Control/Treatment
GVH#1	Hole Completed	0.52	0.44	0.04	Berm/Containment
GVH#3	Hole Completed	0.55	0.47	0.04	Berm/Containment
GVH#4	Hole Completed	0.45	0.38	0.04	Berm/Containment/Silt Fence
GVH#5	Hole Completed	0.51	0.44	0.04	Berm/Containment
GVH#6	Hole Completed	0.46	0.39	0.04	Berm/Containment
GVH#5A	Hole Completed	0.59	0.50	0.05	Berm/Silt Fence
GVH#7, 7A*	Hole Completed	0.33	0.28	0.03	Berm/Silt Fence
GVH#8	Hole Completed	0.65	0.55	0.05	Silt Fence
GVH#9	Hole Completed	0.81	0.68	0.06	Berm/Containment
GVH#5B	Eliminated	-	-	-	-
GVH#8A	Hole Completed	0.49	0.42	0.04	-
GVH#10	Proposed	1.0	0.86	0.08	Berm/Containment
GVH#10A	Proposed	1.0	0.86	0.08	Berm/Containment
GVH#11	Proposed	1.0	0.86	0.08	Berm/Containment
GVH#11A	Proposed	1.0	0.86	0.08	Berm/Containment
GVH#12	Proposed	1.0	0.86	0.08	Berm/Containment
GVH#12A	Proposed	1.0	0.86	0.08	Berm/Containment
GVH#13	Proposed	1.0	0.86	0.08	Berm/Containment
GVH#13A	Proposed	1.0	0.86	0.08	Berm/Containment
GVH#14	Proposed	1.0	0.86	0.08	Berm/Containment
GVH#14A	Proposed	1.0	0.86	0.08	Berm/Containment
GVH#15	Proposed	1.0	0.86	0.08	Berm/Containment
GVH#15A	Proposed	1.0	0.86	0.08	Berm/Containment
GVH#16	Proposed	1.0	0.86	0.08	Berm/Containment
GVH#16A	Proposed	1.0	0.86	0.08	Berm/Containment
GVH#17	Proposed	1.0	0.86	0.08	Berm/Containment

\* GVH #7A (re-drill) on existing pad area GVH #7.



Conclusion

-

Based on an average berm height of 30", the runoff from a 10 year - 24 hour precipitation event can be totally contained on the existing drill pads in an area of approximately 26' x 26', and the runoff from the proposed sites (prior to contemporaneous reclamation) can be totally contained in an area of approximately 37' x 37'. All sites have at least this much area behind the berms for total containment.

Project Title = GVH#1  
WATERSHED HYDROGRAPH  
Inflow into structure # 1  
Structure type: Null

-- Watershed data for watershed # 1

Curve number = 90.0  
Area = 0.5 acres  
Hydraulic length = 200.00 Feet  
Elevation change = 4.0 feet.  
Concentration time = 0.04 hours  
Concentration time type = SCS Upland Curves  
Unit hydrograph type = Disturbed

-- Total Area = 0.5 acres

-- Storm data

Total precipitation = 1.8 inches  
Storm type = SCS Type 2 storm, 24 hour storm  
Peak Discharge = 0.44 cfs  
Discharge volume = 0.04 acre ft

Project Title = GVH#3  
WATERSHED HYDROGRAPH  
Inflow into structure # 1  
Structure type: Null

-- Watershed data for watershed # 1  
Curve number = 90.0  
Area = 0.6 acres  
Hydraulic length = 200.00 Feet  
Elevation change = 4.0 feet.  
Concentration time = 0.04 hours  
Concentration time type = SCS Upland Curves  
Unit hydrograph type = Disturbed

-- Total Area = 0.6 acres

-- Storm data  
Total precipitation = 1.8 inches  
Storm type = SCS Type 2 storm, 24 hour storm  
Peak Discharge = 0.47 cfs  
Discharge volume = 0.04 acre ft

Project Title = GVH#4  
WATERSHED HYDROGRAPH  
Inflow into structure # 1  
Structure type: Null

-- Watershed data for watershed # 1  
Curve number = 90.0  
Area = 0.5 acres  
Hydraulic length = 200.00 Feet  
Elevation change = 4.0 feet.  
Concentration time = 0.04 hours  
Concentration time type = SCS Upland Curves  
Unit hydrograph type = Disturbed

-- Total Area = 0.5 acres

-- Storm data  
Total precipitation = 1.8 inches  
Storm type = SCS Type 2 storm, 24 hour storm  
Peak Discharge = 0.38 cfs  
Discharge volume = 0.04 acre ft

Project Title = GVH#5  
WATERSHED HYDROGRAPH  
Inflow into structure # 1  
Structure type: Null

-- Watershed data for watershed # 1

Curve number = 90.0  
Area = 0.5 acres  
Hydraulic length = 200.00 Feet  
Elevation change = 4.0 feet.  
Concentration time = 0.04 hours  
Concentration time type = SCS Upland Curves  
Unit hydrograph type = Disturbed

-- Total Area = 0.5 acres

-- Storm data

Total precipitation = 1.8 inches  
Storm type = SCS Type 2 storm, 24 hour storm  
Peak Discharge = 0.44 cfs  
Discharge volume = 0.04 acre ft

Project Title = GVH#6  
WATERSHED HYDROGRAPH  
Inflow into structure # 1  
Structure type: Null

-- Watershed data for watershed # 1  
Curve number = 90.0  
Area = 0.5 acres  
Hydraulic length = 200.00 Feet  
Elevation change = 4.0 feet.  
Concentration time = 0.04 hours  
Concentration time type = SCS Upland Curves  
Unit hydrograph type = Disturbed

-- Total Area = 0.5 acres

-- Storm data  
Total precipitation = 1.8 inches  
Storm type = SCS Type 2 storm, 24 hour storm  
Peak Discharge = 0.39 cfs  
Discharge volume = 0.04 acre ft

Project Title = PROPOSED GVH SITES  
WATERSHED HYDROGRAPH

Inflow into structure # 1  
Structure type: Null

-- Watershed data for watershed # 1

Curve number = 90.0  
Area = 1.0 acres  
Hydraulic length = 200.00 Feet  
Elevation change = 4.0 feet.  
Concentration time = 0.04 hours  
Concentration time type = SCS Upland Curves  
Unit hydrograph type = Disturbed

-- Total Area = 1.0 acres

-- Storm data

Total precipitation = 1.8 inches  
Storm type = SCS Type 2 storm, 24 hour storm  
Peak Discharge = 0.86 cfs  
Discharge volume = 0.08 acre ft



(Revised)  
FEBRUARY 2007

**CHAPTER 8**  
**BONDING AND INSURANCE**

## TABLE OF CONTENTS

<u>Section</u>	<u>Page</u>
810 BONDING DEFINITIONS AND DIVERSION RESPONSIBILITIES .....	8-1
820 REQUIREMENTS TO FILE A BOND .....	8-1
830 DETERMINATION OF BOND AMOUNT .....	8-1
840 GENERAL TERMS AND CONDITIONS OF THE BOND .....	8-1
850 BONDING REQUIREMENTS FOR UNDERGROUND COAL MINING AND RECLAMATION ACTIVITIES .....	8-2
860 FORMS OF BONDS .....	8-2
870 REPLACEMENT BONDS .....	8-2
880 REQUIREMENTS TO RELEASE PERFORMANCE BONDS .....	8-2
890 TERMS AND CONDITIONS FOR LIABILITY INSURANCE .....	8-2

## **810 BONDING DEFINITIONS AND DIVERSION RESPONSIBILITIES**

This chapter provides information regarding the bonding for reclamation of the completed and proposed gob gas vent hole sites at the Centennial Project. Andalex, Resources, Inc. has on file with the Division a bond payable to the Division for performance of all requirements of the State Program.

Completed holes are GVH#1, GVH#3, GVH#4, GVH#5, GVH#5A, GVH#6, GVH#7, GVH#7A, GVH#8, GVH#8A, and GVH#9. The following is a list of holes proposed for approval - GVH#10, GVH#10A, GVH#11, GVH#11A, GVH#12, GVH#12A, GVH#13, GVH#13A, GVH#14, GVH#14A, GVH#15, GVH#15A, GVH#16, GVH#16A and GVH#17. All holes are shown on Figure 1-1.

Due to required changes in the mining plan, hole GVH#5B will not be drilled and has been shown as eliminated, although the site has been approved and included in the existing bonding.

## **820 REQUIREMENTS TO FILE A BOND**

A description of the disturbed area location for each well site is found in Chapter 1, Table 1-1. Reclamation of the disturbed areas are discussed in Section 340 of this submittal. The performance bond period is for the duration of coal mining and reclamation operations including the extended period designated by the Division. The bond is in the form of a surety bond and is described in Section 860 of the M&RP.

## **830 DETERMINATION OF BOND AMOUNT**

The existing reclamation bond is posted in the amount of \$1,211,839.00. It has been determined that the total bonding amount for each additional GVH will be \$28,000 per hole. Additional bonding of \$224,000 is presently being secured for the 8 primary sites (GVH#10, GVH#11, GVH#12, GVH#13, GVH#14, GVH#15, GVH#16, and GVH#17). Bonding will be in place for each site prior to any surface disturbing activities.

## **840 GENERAL TERMS AND CONDITIONS OF THE BOND**

Refer to Chapter 8 and Appendix B of the approved M&RP.

**850 BONDING REQUIREMENTS FOR UNDERGROUND COAL MINING AND RECLAMATION ACTIVITIES**

Refer to Chapter 8 of the approved M&RP.

**860 FORMS OF BONDS**

Refer to Chapter 8 of the approved M&RP.

**870 REPLACEMENT BONDS**

Refer to Chapter 8 of the approved M&RP.

**880 REQUIREMENTS TO RELEASE PERFORMANCE BONDS**

The applicant will comply with the requirements described in Section R645-301-880 of the Division regulations when applying for the release of performance bonds.

**890 TERMS AND CONDITIONS FOR LIABILITY INSURANCE**

Certificates of insurance issued for the Centennial Project are included in Appendix B of the approved M&RP.

Bonding Calculations  
Centennial Mine C/007/019

Bond Summary

Direct Costs

Subtotal Demolition and Removal	\$371,538.00
Subtotal Backfilling and Grading	\$426,800.00
Subtotal Revegetation	\$210,074.00
Direct Costs	\$1,008,412.00

Indirect Costs

Mob/Demob	\$100,841.00	10.0%
Contingency	\$50,421.00	5.0%
Engineering Redesign	\$25,210.00	2.5%
Main Office Expense	\$68,572.00	6.8%
Project Mainagement Fee	\$25,210.00	2.5%
Subtotal Indirect Costs	\$270,254.00	26.8%

Total Cost	\$1,278,666.00
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Escalation factor	0.012
Number of years	4
Escalation	\$62,490.00

Reclamation Cost	\$1,341,156.00
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Bond Amount (rounded to nearest \$1,000) 2009 Dollars	\$1,341,000.00
--	----------------

Bond Posted	\$1,211,839.00
-------------	----------------

Difference Between Cost Estimate and Bond	\$129,161.00
Percent Difference	-9.63%

Task ID	Ref.	Description	Materials	Means Reference Number	Unit Cost	Unit	Length	Width	Height	Diameter	Area	Volume	Weight	Density	Time	Number	Unit	Swell Factor	Quantity	Unit	Cost
		Aberdeen Mine																			
		Loadout Bin No 01																			1600
		Concrete No 02																			325
		Reclaim No 03																			2860
		Conveyor No 04																			800
		Hopper No 05																			1200
		Conveyor No 06																			1300
		Tunnel No 07																			1728
		Fan No 08																			840
		Substation No 09																			1914
		Water Tank No 10																			188
		Portals No 11																			2560
		Subtotal																			15135
		Main Office																			
		Main Office No 12																			
		Subtotal																			10889
		Bath House																			
		Bath House No 13																			10889
		Subtotal																			5150
		Upper Pinnacle																			5150
		Substation No 14																			3373
		Loadout Bin No 15																			2245
		Conveyor No 16																			640
		Reclaim No 17																			481
		Hopper No 18																			1152
		Conveyor No 19																			740
		Tunnel No 20																			1728
		Water Tank No 21																			282
		Rock Dust Tank No 22																			314
		Trailers No 23																			3036
		Portals No 24																			14560
		Subtotal																			28531
		Lower Pinnacle																			
		Office No 25																			1998
		Portals No 26																			7680
		Subtotal																			9679
		Shop/Warehouse																			
		Shop/Warehouse No 27																			39105
		Subtotal																			39105
		Apex																			
		Loadout No 28																			1657
		Conveyor No 29																			1120
		Reclaim No 30																			3264
		Hopper No 31																			1843
		Conveyor No 32																			1000
		Tunnel No 33																			2400
		Portals No 34																			13920
		Water Tank No 35																			188
		Shed No 36																			800
		Magazines No 37																			38
		Substation No 38																			1917
		Office No 39																			1755
		Subtotal																			29902
		Culverts																			
		Culverts No 41																			18100
		Subtotal																			18100
		God Vent Well																			
		God Vent Well 1, 3, 4, 5, 5A, 6, 7, 8, 9																			73980
		God Vent Well 2879																			24660
		God Vent Well 10 thru 17																			65760
		Subtotal																			164400
		Vent Shaft Blowing Fan																			
		Aberdeen Substation																			48537
		Subtotal																			2110
		Total																			50647
																					371538

Task ID	Ref.	Description	Materials	Means Reference Number	Unit Cost	Unit	Length	Width	Height	Diameter	Area	Volume	Weight	Density	Time	Number	Unit	Swell Factor	Quantity	Unit	Cost
2359		Gob Vent Well 10 thru 17																			
		7A is a redrill																			
		Structure's Demolition Cost																			
		Plug Well	Mechanical equipment heavy	15055 300 3600	805 /ton												8 tons			32 tons	25760
		Rubble's Weight (exclude steel)	Plug Well	AML3	5000 EA.												8 EA			8 EA	40000
		Truck's Capacity																			
		Haulage																			
		Transportation Cost Non Steel Truck																			
		Transportation Cost Non Steel Drive																			
		Disposal Cost Non Steel																			
		Steel's Weight																			
		Truck's Capacity																			
		Haulage																			
		Transportation Cost Steel Truck																			
		Transportation Cost Steel Truck Drive																			
		Disposal Cost Steel																			
		Subtotal																			65760
		Equipment's Disposal Cost																			
		Dismantling Cost																			
		Equipment's Vol. Demolished																			
		Loading Costs																			
		Transport Costs																			
		Disposal Costs																			
		Subtotal																			
		Concrete Demolition																			
		Demolition Cost																			
		Concrete's Vol. Demolished																			
		Loading Cost																			
		Transportation Cost																			
		Disposal Costs																			
		Subtotal																			
		Concrete Demolition																			
		Demolition Cost																			
		Concrete's Vol. Demolished																			
		Loading Cost																			
		Transportation Cost																			
		Disposal Costs																			
		Subtotal																			
		Concrete Demolition																			
		Demolition Cost																			
		Concrete's Vol. Demolished																			
		Loading Cost																			
		Transportation Cost																			
		Disposal Costs																			
		Subtotal																			
		Concrete Demolition																			
		Demolition Cost																			
		Concrete's Vol. Demolished																			
		Loading Cost																			
		Transportation Cost																			
		Disposal Costs																			
		Subtotal																			
		Total																			65760



Task ID	Task	Equipment Cost	Hourly Operating Costs	Equipment Overhead	Operator's Hourly Wage Rate	Hourly Cost	Number of Men or Eq.	Total Eq. & Lab. Costs	Units	Quantity	Units	Production Rate	Units	Equip. + Labor Time/Dis	Units	Cost
	Gob Hole 10 thru 17															
	Grading 5,000 CY per hole															
	Backfill and rough grade pond, canyon and bench areas															
	D7R Series II (9-55) (2nd2004)	10565	41.1	0.1	52	163.24	1	163.24 \$/HR		40000 CY		250 CY/HR		160 HR		26118
	Subtotal															26118
	Topsoil 1 600 CY per hole															
	Haul and spread topsoil															
	D7R Series II (9-55) (2nd2004)	13720	53.4	0.1	52	196.49	1	196.49 \$/HR		12800 CY		250 CY/HR		51.2 HR		10060
	Subtotal															10060
	Support Personnel															
	4,000 gal H2O Truck Diesel (20-16) (2N04)	3350	19.85	0.1	42	84.77	1	84.77 \$/HR						32 HR		2713
	Subtotal															2713
	Total															38891

Task ID		Equipment Cost	Hourly Operating Costs	Equipment Overhead	Operator's Hourly Wage Rate	Hourly Cost	Number of Men or Eq.	Total Eq. & Lab. Costs	Units	Quantity	Units	Production Rate	Units	Equip. + Labor Time/Dis.	Units	Cost
	Centennial Mine															
	Mine Site															332737
	Gob Hole															43414
2359	Gob Hole 5A, 8A, 7A															11758
	Gob Hole 10 thru 17															38891
	Total															428800

Task ID		Equipment Cost	Hourly Operating Costs	Equipment Overhead	Operator's Hourly Wage Rate	Hourly Cost	Number of Men or Eq.	Total Eq. & Lab. Costs	Units	Quantity	Units	Production Rate	Units	Equip. + Labor Time/Dis.	Units	Cost
	Gob Hole 10 thru 17															
	Grading															
	Backfill and rough grade pond, canyon and bench areas															
	D7R Series II (9-55) (2nd2004)	10565	41.1	0.1	52	163.24	1	163.24 \$/HR		40000 CY		250 CY/HR		160 HR		26118
	Subtotal															26118
	Topsoli 1,600 CY per hole															
	Haul and spread topsoli															
	D7R Series II (9-55) (2nd2004)	13720	53.4	0.1	52	196.49	1	196.49 \$/HR		12600 CY		250 CY/HR		51.2 HR		10060
	Subtotal															10060
	Support Personnel															
	4,000 gal H2O truck Diesel (20-16) (2N04)	3350	19.85	0.1	42	84.77	1	84.77 \$/HR						32 HR		2713
	Subtotal															2713
	Total															38891



Ref.	Description	Materials	Means Reference Number	Unit Cost	Unit	Length
	Gob Holes New					
	Ground Preparation					
	Gouging/Pocking					
	Assume vol = area(18.1 AC) x 1 ft.	Excavation Bulk Bank 2 CY (322BL)	M023154240260		1.7 /CY	
	Seed for hydromulch					
	Hydroseed application	Seed Mix for Centennial Drainage	Centennial 001	447.7 \$/AC		
		Hydro Spreader (equip. & labor) B-81 80MS	Reveg002	19.13 /MSF		
	Mulch material	Hay 1" material only 029105000250	Reveg001	68 /MSF		
	Hydroseed application	Hydro Spreader (equip. & labor) B-81	Reveg005	19.13 /MSF		
	Subtotal					
	Reseeding					
	Assume 25% reseeding rate					
	Subtotal					
	Total					



Cost
5440
3582
6657
544
6657
22880
5720
5720
28600